REVISION OF AUSTRALIAN SPECIES OF SCOMBEROMORUS.

BY CAPTAIN IAN S. R. MUNRO, B.Sc.

(AUSTRALIAN ARMY MEDICAL CORPS, AUSTRALIAN IMPERIAL FORCE.)

Plates VI–VIII.

Introduction.—The Spanish Mackerel comprise an important group of deep-sea food fishes which support a valuable coastal pelagic fishery in Australian waters, particularly Queensland, northern New South Wales and Western Australia. The industry is based primarily on one particular species, namely the Barred Spanish Mackerel, *Scomberomorus* (*Cybium*) *commerson* caught by trolling in coastal waters. Another migratory species, *Scomberomorus* (*Cybium*) *queenslandicus* sp. nov., enters the estuaries along the coast during the winter months and in season supports a small net fishery. There are in addition several other marketable Spanish Mackerels, which, being caught in smaller numbers, are rather too rare to be of economic importance. All the Australian species, like their relatives from overseas, are recognised as first class food-fishes and, in addition, the larger forms provide abundant sport for Game anglers along the coast of New South Wales and the Great Barrier Reef.

Since there appears to be a decline in the annual catches of these fishes per unit of fishing effort despite improvements in technique and equipment, and because there has been an enormous increase in fishing activities during the spawning season, investigations concerning their biology and economics have been instigated in order that sound scientific conservational measures might be derived. It is hardly necessary to emphasise the economic consequences resultant from over-exploitation of the fishery and the effect of decreased output upon the livelihoods of all whom the industry concerns.

The first problem in this study concerns the exact diagnosis and subsequent identification of all species. Until a clear conception of the species which comprise the schools inhabiting our waters has been formulated it is impossible to expect any progress in the understanding of their Biology. As could be expected, the handling of many thousand specimens in the field and careful laboratory examination have revealed the need for revising existent conceptions of the identity of Australian forms.

Summary.—Various aspects of the taxonomy of the genus *Scomberomorus* Lacépède are here discussed. Nine subgenera are recognised and two of these (*Indocybium* and *Pseudosawara*) are described as new. Subgeneric characters and phylogeny are discussed.

Four valid species of Spanish Mackerels are shown to occur in Australian seas. These are illustrated and fully described from series of specimens. Distribution, nomenclature and morphological features are discussed in detail for each species.

Formerly three Australian species had been recognised, namely *S. commerson*, *S. guttatus* and *S. semifasciatus*. It is here shown that the spotted form *S. guttatus* (Bl. & Schn.) does not occur in Australian waters. In addition *S. niphonius* (Cuv.

& Val.), a Japanese form, has been added to Australian lists as a new record and a common commercial species is recognised as new and here described under the name *Scomberomorus* (*Cybium*) *queenslandicus*.

REVIEW AND ANALYSIS OF THE GENUS SCOMBEROMORUS LACÉPÈDE.

(A) DISTRIBUTION.—The fishes of the Scomberomoridae are without exception coastal inhabitants. Throughout the world they are seldom found in water deeper than forty fathoms. Some species frequent estuarine waters at certain seasons of the year, some prefer discoloured waters but the majority of species inhabit the clear tropical waters of ocean currents around rocky islets and coral reefs, tide rips and off-shore currents. Their preference for waters of low density and medium salinity apparently accounts for their coastal distributions. All known species, about twenty in number, are of tropical or subtropical coastal distribution. Apparently temperature is a governing factor in geographical distribution, as the range of all known species falls within the boundaries set by the 68° F. summer ocean isotherms of both hemispheres. In this respect they are seen to resemble the allied genus *Acanthocybium* but differ from *Grammatorcynus* whose limits are the 77° F. summer ocean isotherms. In most cases annual spawning migrations are made to keep within these temperature limitations.

(B) NOMENCLATURE—*Cybium* or *Scomberomorus* ?—During the past sixty years there has been much controversial opinion amongst systematic ichthyologists regarding the use of the names *Scomberomorus* Lacépède and *Cybium* Cuvier. Prior to the resurrection of the former name by Jordan and Gilbert (Proc. U.S. Nat. Mus., V, 1883, p. 573), *Cybium* had been applied almost universally and without question by all European authorities following its adoption first by Cuvier in 1829 (Regne Anim. ed. 2, II, p. 199). Although there is a modern tendency to associate these names with separate subgenera, it must be admitted that the original conception of the two names was one of synonymy. *Scomberomorus* Lac. has chronological priority over *Cybium* Cuvier, and should be adopted on these grounds. There is no reason why its validity should be doubted on the grounds given by Kishinouye (1923, Journ. Coll. Agric., Univ. Tokyo, VIII, p. 416), namely that Lacépède's description of the genotype *Scomberomorus plumierii* from Martinique (Hist. Nat. Poiss., III, 1802, p. 292) being drawn up from Aubriet's inferior copy of Plumier's painting was diffuse and inaccurate. It is true that Lacépède (*loc. cit.*, IV, p. 711 ; V, p. 789) tried to withdraw his genus upon recognition of the synonymy of this species with *Scomber regalis* Bloch from Antilles (Nat. ausl. Fische, VII, 1793, p. 38, pl. 333) but he did appreciate generic differences between this fish and the genus *Scomber* Linnaeus. If one generic name is to be adopted to denote this group, then the older name *Scomberomorus* Lac. must take precedence.

An exhaustive study of the literature pertaining to this particular group of fishes—some 400 references in all—reveals that this *Scomberomorus* of Lacépède can be subdivided conveniently into nine subgenera. Generally speaking the name *Scomberomorus* Lac. designates that group of Scombroid fishes with a more or less laterally-compressed elongate body covered with minute scales not differentiated to form a corselet in the pectoral region. A single lateral line distinguishes it from *Grammatorcynus* Gill and the possession of a few gill-rakers separates it from *Acanthocybium* Gill. Most other characters are variable, especially vertebral and gill-raker counts. Likewise the swim-bladder is of doubtful constancy and apparently

may vary within the geographical races of the same species, *e.g. Cybium commerson* where it occurs in the Japanese race but is absent in Australian specimens.

(C) Sub-genera—Characters and Species Allocation :

(i) *SCOMBEROMORUS* Jordan & Hubbs, 1925.

Jordan & Hubbs, Mem. Carneg. Mus., X, 2, 1925, p. 212.
Deraniyagala, Ceylon J. Sci. (B), XVIII, p. 38, 1933 (in part).

Air-bladder present ; lateral line simple ; 17-18 spines in first dorsal fin ; 11-14 gill-rakers on lower branch of first gill-arch ; teeth straight and laterally compressed, non-serrulate.

S. regalis (Bloch), *S. maculatus* (Mitchill) and *S. sierra* Jord. & Starks from North America and *S. tritor* (Cuv. & Val.) from N.W. Africa. Not Australian. Modern authorities claim the synonymy of *S. maculatus* (N. America, Atlantic) = *S. sierra* (N. America, Pacific) = *S. tritor* (N. W. Africa, Atlantic). These are probably geographical races of the same species. In this connection can be noted that the suggested synonymy of Bennett's genotype *Apolectus immunis* from N. W. Africa should not be with American *S. maculatus* but more strictly = *S. tritor* from same type locality. If Bennett's teeth characters can be considered as erroneous and the above synonymy adopted, then subgenus *Scomberomorus* J. & H. is synonymous with *Apodontis* Benn. (= *Apolectus* Benn., preocc.—1831, Proc. Comm. Zool. Soc., I, p. 169 and p. 146).

Genotype = *Scomber regalis* Bloch (Antilles) (= *Scomberomorus plumierii* Lacépède (Martinique).)

(ii) *CYBIUM* Jordan & Hubbs, 1925.

Jordan & Hubbs, Mem. Carneg. Mus., X, 2, 1925, p. 212.
Fowler, Hong Kong Nat., VII, 1936, p. 70 (in part).

Cibium of Troschel (Arch. f. Naturg., Weigman, XV, 1, 1849, p. 380) though probably intended to carry the same significance as *Cybium* Cuvier (Regne Anim., ed. 2, II, 1829, p. 199) was never the less designated with having three gill-rakers. Mention of this character specifically conveys essentially the same restricted meaning as subgenus *Cybium* J. & H.

Gill-rakers very short and few in number ; teeth laterally compressed, with minutely serrulate edges ; swim bladder present or absent as stated above ; lateral-line simple with vestigial ramification in older age groups ; 16 spines in first dorsal fin.

S. commerson (Lacep.) from Indo-Pacific (Africa, Red Sea, India, Malaya, China, Japan, Indian Archipelago and Australia) and *S. queenslandicus* sp. nov. from N.E. and N.W. Australia. Note—no other Australian forms are referable to subgenus *Cybium* though listed by Whitley (Mem. Qld. Mus., XI, 1936, p. 32), morphological differences being more significant than geographical distribution.

Genotype = *Scomber commerson* Lacep. (= *Cybium commersonii* Cuv. (Mauritius)). (Also = genotype of *Cybium* Cuv. by designation, Gill, 1863, Proc. Acad. Nat. Sc. Phila., p. 126).

(iii) *SAWARA* Jordan & Hubbs, 1925.

Jordan & Hubbs, Mem. Carneg. Mus., X, 2, 1925, p. 214.
? Deraniyagala, Ceylon J. Sci. (B), XVIII, 1933, p. 38.
Fowler, Hong Kong Nat., VII, 1936, p. 70 (in part).

Sawara was originally erected for reception of *Cybium niphonium* C. & V., which was stated by Kishinouye (Journ. Coll. Agric. Univ. Tokyo, VIII, 1923, p.

421) to be specially characterised by a branched lateral line and the absence of a swim bladder. There are said to be short sharp branch canals on either side of the lateral line. They are apparently true ramifications as are seen well developed in *Acanthocybium* or vestigially in older age groups of *S. commersion, i.e.*, morphologically different from the "branching" in *Pseudosawarra*. It is doubtful whether the branches are as distinct as depicted by Kikkawa (Kishinouye, *loc. cit.*, p. xx, f. 32) or as copied by Fowler (Hong Kong Nat., VII, 1936, f. 7). I am not willing to accept that Australian specimens (age groups normally caught) possess a branched lateral line, but admittedly there is a wide band of enlarged scales fringing both sides of the lateral line and superficially these give an appearance of vestigial ramification of the main canal. In this connection it is of interest to note that Tanaka (Fishes Japan, IX, 1912, p. 154) does not remark on lateral-line ramification and Tortonese (Boll. Mus. Zool. Anat. Comp. Torino, XLVII, 1939, p. 321) revived Günther's name *gracilis* for application to an immature oriental specimen with simple lateral line. Ramification of the lateral line in the genotype is therefore questionable and is probably, if existent, an age effect as in *S. commerson*. The abnormally large number of dorsal spines (20–22) becomes the principal subgeneric character of *Sawara*.

S. niphonius (C. & V.) is sole representative, from Japan and East coast of Australia. It is fairly certain that *C. gracile* Günth. and *S. gracilis* Tort. are synonyms of this species.

(iv) *PSEUDOSAWARA* Subgenus Nov.

A new subgenus is necessary for reception of two species possessing another type of lateral-line branching. This is not true ramification but a branching effect produced by the continuation backwards of the area of minutely furrowed skin caused by presence of tracts of cutaneous mucous canals. Such areas are seen on the postero-dorsal region of the head of all species of *Scomberomorus*. In the subgenus *Pseudosawara* such canals are bunched together along both sides of the lateral line as well as on the head. They all point outwards and backwards and are densest towards the anterior part of the lateral line. Gill-rakers 11-13 ; Dorsal spines 14-16.

S. kuhlii (C. & V.) (= *C. guttatum* of Kishinouye, Journ. Coll. Agric. Univ. Tokyo, VIII, 1923 and Deraniyagala, Ceylon J. Sci. (B), XVIII, 1933 = *S. kuhlii* Day, Fish. India, 1876, p. 254, pl. lvi, f. 2) from India, Indian Archipelago and Japan. Also *S. koreanus* Kish. from Korea only. No Australian species.

Genotype—*Cybium kuhlii* Cuv. & Val. (Hist. Nat. Poiss., VIII, 1831, p. 178) from Java.

(v) *INDOCYBIUM* Subgenus Nov.

Indocybium is proposed as a new subgenus to receive at least three Indo-Pacific species which can be readily distinguished by virtue of distinctive body proportions. Compared with other subgenera the head is smaller, the flukes of the caudal fin larger. The distance between tips of anal and soft dorsal fins large. Lateral line simple ; swim-bladder absent ; gill-rakers = 2 + 8 or 11 ; 13-17 dorsal spines ; teeth compressed, non-serrulate and slightly curved inward.

S. semifasciatus (Macleay) (= *C. tigris* De Vis) from Queensland ; *S. lineolatus* (Cuvier) (= *C. interruptum* C. & V.) from India, Indian Archipelago and Africa ; *S. guttatus* (Bloch & Schneider) India and Indian Archipelago.

Genotype = *Cybium semifasciatum* Macleay, Proc. Linn. Soc. N.S.W., VIII, 1883, p. 205 (Burdekin R., Qld.).

(vi) *SIERRA* Fowler, 1905.

Fowler, Proc. Acad. Nat. Sci. Phila., LVI, 1905, p. 766.

Large forms with greatly flexed unbranched lateral line ; gill-rakers 1 or 2 + 8 or 9 ; dorsal spines 14-16 ; teeth straight and compressed.

S. cavalla (Cuv.) from Atlantic coast N. America and Brazil ; *S. sinensis* (Lacép.) (= *C. cambodgiense* Durand, Instit. Oceanogr. l'Indochine, XXXVI, 1940, p. 37, pl. vi—immature) from N. China & Japan may belong to this subgenus. Not Australian.

Genotype = *Cybium cavalla* Cuvier, Regne Anim., ed. 2, II, 1829, p. 200 (after Marcgrave, from Brazil).

(vii) *CHRIOMITRA* Lockington, 1880.

Lockington, Proc. Acad. Nat. Sc. Phila, 1879, p. 133.

Chriomitra is represented by a single species of rare occurrence and limited in distribution to part of Californian coast. Lateral line apparently simple ; gill-rakers abnormally numerous *viz.* 18. The two dorsal fins are separated by a gap as in *Cybiosarda* and *Sarda*. This fish has never been illustrated. It is apparently a true Scomberomorid.

Genotype = *Chriomitra concolor*, Lockington, Proc. Acad. Nat. Sc. Phila., 1879, p. 133 (Monterey Bay, Calif.). This is only known species. Not Australian.

(viii) *CYBIOSARDA* Whitley, 1935.

Whitley, Rec. Aust. Mus., XIX, 4, 1935, p. 236.
Whitley, Mem. Qld. Mus., XI, i, 1936, p. 42.

Cybiosarda Whitley may not be strictly Scomberomorid—lying on border line between *Sarda* and *Scomberomorus*. It is probably closest to *Sarda* which it resembles in external features and skeletal characters. That the first spine of spinous dorsal fin is longer than second spine rather excludes it from being truly Scomberomorid. The form of the teeth (sub-conical and curved) as well as their arrangement are typically *Sarda*. *Chriomitra* is apparently a phylogenetic link between *Cybiosarda* and more typical Scomberomorids.

Cybiosarda elegans from E. & W. coasts of Australia is only species.

Genotype = *Scomberomorus* (*Cybiosarda*) *elegans* Whitley, Rec. Aust. Mus., XIX, 4, 1935, p. 236 (Moreton Bay, Qld.).

(ix) *LEPIDOCYBIUM* Gill, 1863.

Gill, Proc. Acad. Nat. Sci. Phila., 1863, p. 125.

Gill erected this genus for *Cybium flavo-brunneum* Smith. It differs significantly from all other Scomberomorids by fact that teeth are conical and recurved—those of upper jaw series being larger than those in the lower jaw. The first dorsal fin has

12 low spines and anal and dorsal finlets are reduced to 4 or 5. Not strictly Scomberomorid and phylogenetically constitutes a possible link between more typical Scomberomorids and *Thyrsites* or *Ruvettus* of the Gempylidae, especially in relation to the dentition and reduction of finlets.

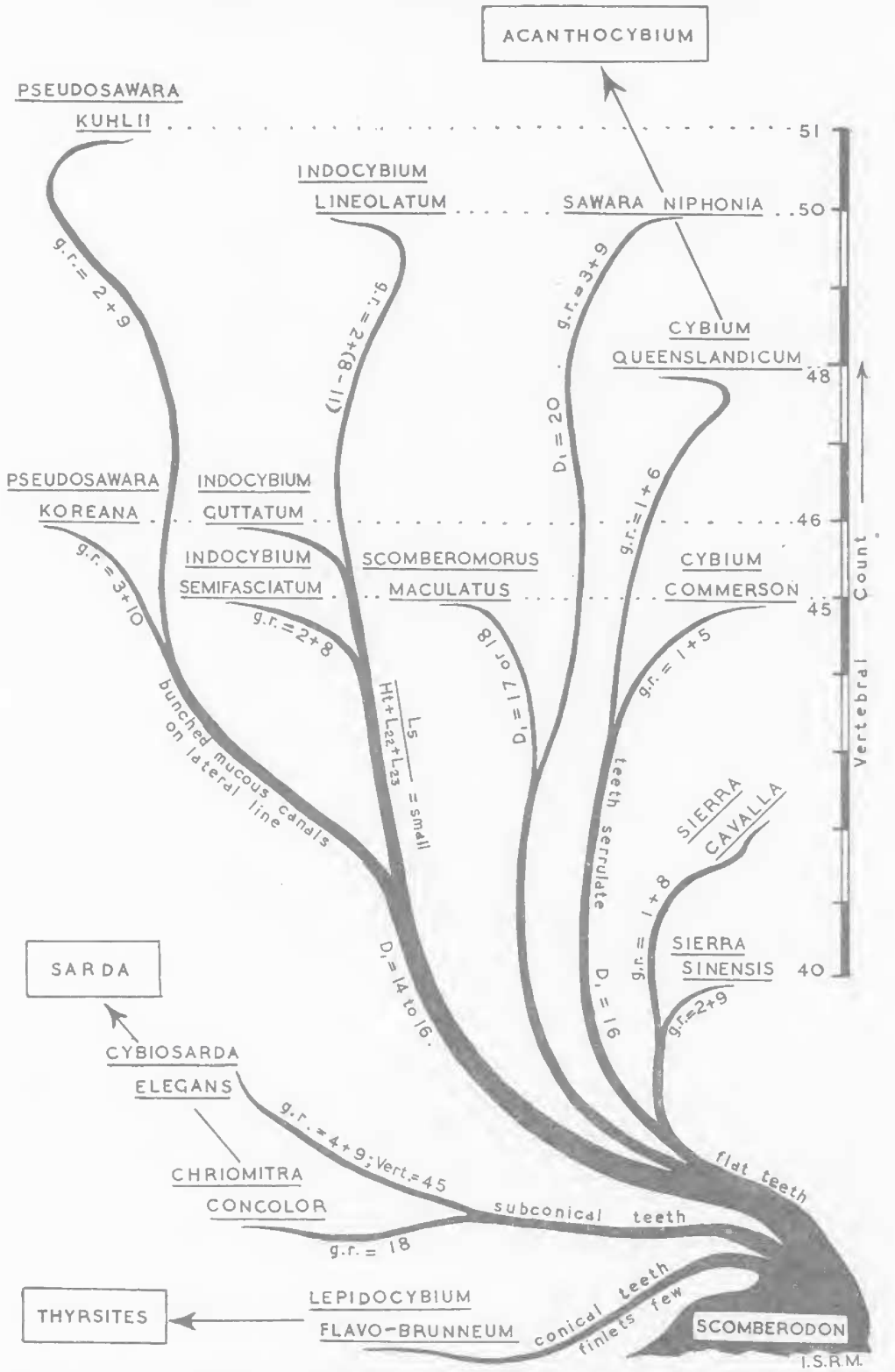
There is only one species—*L. flavobrunneum*. It is rare but widely distributed. Its greatest interest lies in the fact that a survey of the relevant literature has brought forth some new points in synonymy of this species. Only one South African specimen (the genotype) is known and upon this is based the records of Smith 1849 (Cape of Good Hope), Günther 1860, Bleeker 1860, Gill 1863, Gilchrist 1902, Thompson, 1918 and Barnard 1927. Weber (Abhandl. Senck. Naturf. Ges., XXXIV, 1911, p. 31) records it from Aru Is. (Barkai). It has been redescribed under three different names but nobody seems to have associated these with the earliest combination, *i.e. Lepidocybium flavo-brunneum* (Smith). The synonyms over which this combination takes priority are—*Xenogramma carinatum* Waite (Rec. Aust. Mus., V, 1904, p. 158, pl. xix, f. 1, Lord Howe Is.), *Diplogonurus maderensis* Noronha (Ann. Carneg. Mus., XVI, 3-4, 1926, p. 381, f. 1 ; also Fowler, Bull. Amer. Mus. Nat. Hist., LXX, 2, 1936, p. 627, 1275, f. 545, Madiera) and *Lepidosarda retigramma* Kishinouye (Journ. Coll. Agric. Univ. Tokyo, VII, 4, 1926, p. 377, f. 1—Japan). Careful perusal of descriptions and comparison of figures will confirm this view.

(D) Phylogenetic Interpretation of Genera and Species.—To assist in the diagnosis of Australian forms Table I. is provided, setting out salient characters of each valid species and Text-fig. I. giving an indication of origin and interrelations of species concerned.

The nine subgenera represent trends in different directions diverging from some common ancestral stock or archaic form or forms constituting the now extinct analogous genus *Scomberodon* van Beneden (Bull. Acad. Roy. Belg. (2), XXXI, 1871, p. 504), evidence of the existence of which comes from Miocene, Oligocene and Eocene clays of Europe, N. America and the Indian Archipelago. It is of interest to note that species were on the average larger in size than modern representatives of the genus and the vertebral number was smaller (*e.g.* 15 + 15 = 30 in *Cybium speciosum* Ag.) (*vide* Woodward, B. M. Cat. Foss. Fish., IV, 1901, p. 465 ; Dollo & Storms, Zool. Anzeiger, XI, 1888, p. 265). The teeth of fossil forms are described as conical or flattened, usually broad and invariably laterally compressed. In dentition at least most Scomberomorids have diverged little from their ancestral stock but there is a definite tendency towards increase in the vertebral count. Variation in vertebral count makes it impossible to use this character for a primary subdivision of the genus. Variation in vertebral count in each subgenus can be considered in the light of a phylogenetic progression along each branch. In respect to manifestation of high vertebral count, *Pseudosawara kuhlii* (51), *Indocybium lineolatum* (50), *Sawara niphonia* (50) and *Cybium queenslandicus* (48) show a convergence towards *Acanthocybium* which has 54-64 vertebrae. *S. niphonia* shows further convergence in this direction in respect to the long dorsal fin (20-22 spines, cf. Wahoo 25-26 spines). Subgenus *Cybium* shows similar approach from another angle, namely by reduction in size and number of gill-rakers, branching of lateral line and development of perfectly flat teeth with minutely serrulate edges.

TABLE I—CHARACTERS OF THE GENUS *Scomberomorus* Lacépède. (Maximum known range of variation given in each case.)

Subgenus.	Species.	Vertebrae.	Gill-rakers.		Pectoral Fin.	Dorsal Fins.			Anal Fins.		Adult Markings.
			Upper.	Lower.		D_1	D_2	Finlets.	A.	Finlets.	
Sierra Fowler	*S. sinensis*	18 + 22 = 40	2	9	18–22	16	15–16	7–8	15–19	6–7	Large blotches
	S. cavalla	..	1–2	6–8	22	14–16	15–17	8–9	16–17	8–10	Immaculate
Cybium Jord. & Hubbs	*S. commerson*	20 + 25 = 45	0–2	3–6	21–24	14–17	16–19	8–10	14–18	8–10	Vertical bars
	S. queenslandicus	20 + 28 = 48	0–1	4–7	20–23	15–17	16–20	9–10	15–20	9–10	Large blotches
Scomberomorus Jord. & Hubbs ..	*S. maculatus*	45	2–3	10–13	18–22	17–18	15–18	7–9	17–19	8–9	Small spots
	S. sierra	..	3–4	11–13	..	17–18	15–16	8–9	17	8–9	Small spots
	S. tritor	..	4	12	20–22	17	16–17	8–10	16–18	8–10	Blotches
	S. regalis	..	2–3	11–12	..	17–18	15–17	8–10	16–19	8–10	Elongate spots
Sawara Jord. & Hubbs	*S. niphonius*	22 + 28 = 50	2–3	9–11	21–23	20–22	16–19	8–10	15–18	8–9	Small spots
Indocybium Subgen. nov.	*S. semifasciatus*	19 + 26 = 45	2–3	7–8	22–23	13–15	17–20	8–10	20–22	8–10	Vertical bars
	S. guttatus	20 + 26 = 46	2	9	21	15–17	18–20	8–9	19–21	8–10	Small spots
	S. lineolatus	21 + 29 = 50	2–3	8–11	21–23	15–17	18–20	9–10	18–21	9–10	Horizontal streaks
Pseudosawara Subgen. nov.	*S. koreanus*	20 + 26 = 46	3	10	..	14	19–21	9	18–21	7	Small spots
	S. kuhlii	21 + 30 = 51	2–3	8–9	20–23	15–16	18–20	8–9	19–21	7–9	Small spots
Chriomitra Lockington	*S. concolor*	..	..	16–18	..	15–17	16–18	7–9	16–20	7–8	Immaculate
Cybiosarda Whitley	*S. elegans*	45	4	9	..	15–16	16–17	9–10	15–16	7–8	Spots and horizontal stripes
Lepidocybium Gill	*S. flavobrunneus*	17 + 15 = 32	0	0	15	12	17–18	5	14–15	4–5	Immaculate
?	*S. croockewitii*	..	..	..	20	15	17	7	20	7	Broad stripe
?	*S. clupeoideus*	..	..	..	..	14	17	9	16	9	Immaculate
Maximum variations in Genus *Scomberomorus* Lacépède ..	..	32–51	0–4	0–18	15–23	12–22	15–21	5–10	14–21	4–10	



Text-fig. 1.—Diagram to illustrate the morphological relations and probable phylogenetic trends of world species of the genus *Scomberomorus* Lacépède.

The species are arranged on the diagram graphically in relation to the scale on the right to indicate the number of vertebrae in each; g.r. = number of gill-rakers and D_1 = number of spines in the first dorsal fin.

Generally speaking the branches *Sierra*, *Cybium*, *Sawara* and *Scomberomorus* have ratio of head length to body length small and number of dorsal fin spines large, while *Indocybium* and *Pseudosawara* have fewer dorsal fin spines and head length to body length relatively larger.

Geographical distribution shows that *C. commerson*, which morphologically resembles *Acanthocybium* in many ways, has been the most successful of modern Scomberomorids. The suggestion is that the type of body form adopted by *S. commerson* and *Acanthocybium* has proven the most suitable for life under oceanic conditions and for making long migrations. Those types which have developed in the opposite direction by shortening the head and increasing the body depth have had relatively less success and are restricted to shallow calmer coastal seas and their geographical range is limited.

THE AUSTRALIAN SPECIES OF SCOMBEROMORUS LACÉPÈDE.

The investigation of the Australian species of Spanish Mackerel has led to the establishment of the fact that there are four distinct species which belong to three subgenera. It has been generally accepted by Australian ichthyologists that there were three species in our waters. These are the Barred Spanish Mackerel or Giant Mackerel (*S. commerson* (Lacép.)), Grey Mackerel (*S. semifasciatus* (Macleay)) and some mysterious spotted variety hitherto erroneously recorded as *S. guttatus* (Bl. & Schn.). Examination of specimens in the Australian Museum collection and extensive field observations reveal that there is no species on the coast which has claim to the name *guttatus*. The "Spotted Spanish Mackerel" of Australian authors belong in reality to two distinct and easily recognisable forms; the discovery of one (*S. niphonius*) constitutes a new Australian record, whilst the other (*S. queenslandicus*) proves to be new to science.

These four species can be keyed out simply and distinguished from their close relatives *Acanthocybium* and *Grammatorcynus* as folows :—

KEY TO AUSTRALIAN SPECIES OF *SCOMBEROMORUS*.

1. Two lateral lines, body scaly .. .. *Grammatorcynus bicarinatus.*

2. Single lateral line, body scales very minute.

A. Spinous dorsal fin with 25-26 rays, jaws beak-like, gill-rakers absent, specialised scales above pectoral fin, lateral line with numerous long branches .. .. *Acanthocybium solandri.*

AA. Spinous dorsal fin with 14-20 rays, gill-rakers present, no great specialisation of corselet scales.

a. Gill-rakers rudimentary, never more than 1 + 6; teeth flat, compressed and minutely serrulate; 16-17 dorsal spines.

i. Body marked with numerous narrow wavy bands on belly; lateral line with sharp inflection below second dorsal finlet .. .. *Scomberomorus (Cybium) commerson.*

ii. Body marked with diffuse rounded blotches, each larger than diameter of the eye and arranged in about three rows below lateral line; lateral line without a deep inflection .. .. *Scomberomorus (Cybium) queenslandicus.*

aa. Gill-rakers well developed, 2 + 8 or 9; teeth slightly curved inwards but not serrulate.

i. Body marked with anastomosing spots about size of pupil of eye and confined to a band along middle of side; Spinous dorsal with 19-20 rays .. .. .. *Scomberomorus* (*Sawara*) *niphonius.*

ii. Body marked with a few broad straight vertical bands on its upper portion; Spinous dorsal with only 14 rays; head very small .. .. *Scomberomorus* (*Indocybium*) *semifasciatus.*

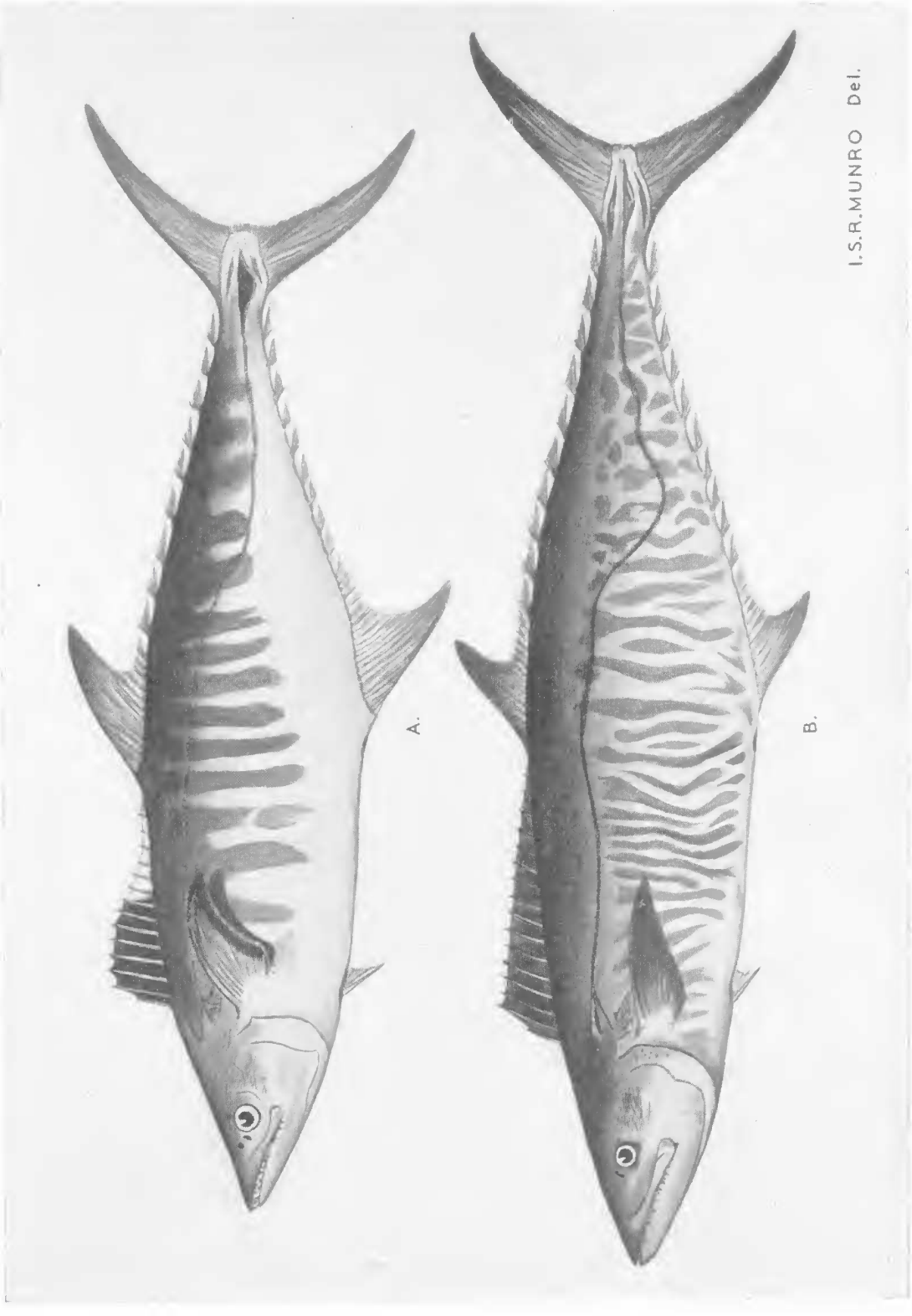
SCOMBEROMORUS (CYBIUM) COMMERSON (Lacépède) 1800.

NARROW-BARRED SPANISH MACKEREL.

Plate VI and VIII.

1. DISTRIBUTION.—If all records of this name apply to a single homogeneous species the distribution of *S. commerson* is wider than for any other species of the genus. It occurs at least seasonally throughout all waters in Indo-Australian Region, the Red Sea and the East coast of Africa. The extreme limits of geographical range are approximately 40° N. and 40° S. latitude. On the African coast its range is at least from Cape of Good Hope to Zanzibar, Mauritius (Type locality) and the Red Sea. It is well known in India, Ceylon, Bay of Bengal, Siam, Malaya, Singapore, China, Japan, Formosa, Phillipines, Sumatra and Indian Archipelago generally. In New Guinea waters it has been officially recorded from Aru Is. (Weber) and Hood Bay (Macleay) and there is a specimen in the Australian Museum (IA. 5679) from Eastern Papua (between Pt. Glasgow and Suau Is.). It is apparently very common in Torres Straits and there is reason to believe that it is known in North Australian waters (Pellew Waters, Paradice & Whitley) but I have seen no specimens to confirm this. Mr. J. Gregory, Field observer for C.S.I.R. Fisheries Laboratory, has confirmed the existence of this species along the West Australian coast where it is known as "Albacore" and there is a large specimen in the Perth Museum (116·6 cm.). Mr. Gregory's records are for Albrolhos Is., Geraldton, Sharks Bay, Dirk Hartog Is. and Rottnest Is. Dampier's "Fish of the Tunny kind" from Sharks Bay (Voy. New Holland, III, 1703, pl. 3, fig. 5, p. 162) may refer to this species. On the eastern Australian coast it is perhaps better known than anywhere else. It is abundant all along the coasts of Queensland and New South Wales, especially along the islands of the Great Barrier Reef. Fishermen seek it as far north as Princess Charlotte Bay and there is a specimen in the Australian Museum (I. 14566) from Cooktown. I have seen many thousands from fishing grounds between Cairns and Coffs Harbour. It is known to occur as far south as Pt. Jackson (specimens in Australian Museum—I. 9693, B. 584) and on one occasion to Port Phillip Bay (McCoy, 1890). Mr. Blackburn of C.S.I.R. Fisheries Laboratory tells me of a 9 lb. specimen caught in March 1938 off St. Helens, Tasmania. In the Pacific, records indicate Fiji Is. only (Jordan & Dickerson), but doubtlessly it is found at New Caledonia (*vide* Priday, 1942, "Walkabout," Jan. 1st), Solomon Is. and elsewhere. No records have ever come from New Zealand.

2. DESCRIPTION.—(*a*) *Size*—Age groups normally caught in winter months in Australian waters fall into two categories, namely 9 lb.-12 lb. and 30 lb. Occasionally fish weighing 50 to 60 lb. are caught in North Queensland and Western Australian waters and anything above this weight is of quite exceptional occurrence. Fish of 40-50 lb. weight measure 4 ft. 6 in. (140 cm.). They are known to grow to a length of about 6 ft. (90-100 lb.) in Australia and other parts of the world, but it is difficult to procure official records.



Australian Spanish Mackerel.

Fig. A.—*Scomberomorus* (*Indocybium*) *semifasciatus* (Macleay), Broad-barred Spanish Mackerel or Grey Mackerel. Specimen from Mackay district, North Queensland, 4th September, 1941. Queensland Museum Collection Registered No. I 7375. Length to caudal fork = 451 mm.

Fig. B.—*Scomberomorus* (*Cybium*) *commerson* (Lacépède), Narrow-barred Spanish Mackerel, Giant Mackerel, or Kingfish. Specimen from Cape Moreton, South Queensland, 4th August, 1941. Length to caudal fork=968 mm.

(*b*) *Colour.*—The following colour notes apply to freshly caught specimens from the Queensland coast :—Cranial regions and upper regions of back are mottled with iridescent blue and green with some purple and bronze colours giving a " shot " appearance which rapidly changes to deep blue. Below the level of the lateral line from the snout to the caudal fork the sides are a pale silver grey with some iridescent shades and marked with transverse vertical bars of a darker grey, these extending upwards into the darker zone above the lateral line where they fade away. These bars are narrow and slightly wavy and often break up into spots in the belly region. This condition is most marked in the bars nearest the tail and in young fish. There are about 40 or 50 such bands in mature fish but there is usually less than 20 in fish up to 18 inches long. The cheeks, lower jaw and belly region are silvery white. Spinous dorsal fin is bright blue with white spines which rapidly fades to a blackish blue. The pectoral fin is a light grey which likewise turns to a blackish blue. The caudal flukes, soft dorsal, anal fins, and dorsal and anal finlets are a pale greyish white colour which quickly turn to dark grey with a tinge of blue-green or yellow. In younger specimens the membrane of the spinous dorsal fin is pure white with contrasting jet black areas anteriorly.

(*c*) *Fin Formulae.*

TABLE II.—FIN COUNTS IN *S. commerson*. SERIES FROM QUEENSLAND WATERS.

No. of Spines and Rays.	8	9	10	11	14	15	16	17	18	19	21	22	23	24	Total No. Individuals.
1st Dorsal ..					3	6	28	3							40
2nd Dorsal ..							9	19	9	1					38
Dorsal Finlets ..		18	19	3											40
Anal					1	0	3	16	1						21
Anal Finlets ..	3	24	11												38
Pectoral											2	19	13	3	37

In the above table (II) is defined the range of variations of counts of spines in various fins of *S. commerson* from Queensland waters, namely :—

D, 14-17 ; 16-19 ; 9-11. A, 14-18 ; 8-10. P, 21-24.

From this can be drawn up a more usual or average fin formula, namely :—

D, 16 + 17 + 10. A, 17 + 9. P, 22-23.

It is of interest to note that the above, compiled from original observations on Queensland fish, is essentially similar to that recorded for the classical examples from other parts of this species world range. For comparison these figures are reproduced in table III. The fin formulae given in these descriptions all fall within the range of variation of Australian fish.

TABLE III.—FIN FORMULAE OF *S. commerson* FROM VARIOUS WORLD LOCALITIES.

D1	D2	D-Finlets.	A	A-Finlets.	P	Authority.	Locality.
16	16	10	16	9	22–23	Cuv. & Val. 1831	? Mauritius
16	16	10	16	10		Gilchrist & Thompson, 1909 ..	Natal Coast
16-17	15–17	9–10	14–17	9–10		Barnard, 1927	Sth. Africa
15–16	14–16	9–10	17	9–10		Klunzinger, 1871, 1884	Red Sea
16	14	10	17	10	24	Rüppell, 1828	Red Sea
16	16	10	14	12	22	Russell, 1803	India
16–17	16–18	9–10	14–16	9–10	20–23	Day, 1876, 1889	India
17	17	10	17	10	23	Cantor, 1850	India
15–16	16–17	9–10	17	9–11	23	Deraniyagala, 1933..	Ceylon
17	16	10	16	10		Kner, 1869	Manilla
16	17	10	14	9		Jord. & Seale, 1907	Philippines
17	15	9	14	9		Kishinouye, 1923	Japan and Formosa
16	17	9–10	17	9–10		Macleay, 1881	Pt. Jackson, Aust.
16	17	10	17	9	24	McCoy, 1890	Pt. Phillip, Aust.
15–16	15–17	9–10	15–17	9–10	22–23	Whitley, 1936	Queensland

(d) Body Proportions.

TABLE IV: BODY PROPORTIONS OF *Scomberomorus commerson*. SERIES FROM EAST COAST OF AUSTRALIA—NEW GUINEA TO PORT JACKSON. SIZE RANGE (L.C.F.) 368 mm. TO 1252mm.

Ratio.	Number of Specimens.	Observed Range.		Mean.	σ	Coefficient of Variation
		Minimum.	Maximum.			
Head length/snout length	42	2·19	2·53	2·36	0·072	3·0%
Head length/eye diameter	42	6·00	11·84	8·18	1·04	12·7%
Head length/inter-orbital	42	2·59	4·64	2·98	0·302	10·1%
Head length—maxilla length	42	1·66	2·14	1·75	0·079	4·5%
Head length/pectoral fin length	42	1·46	1·80	1·58	0·084	5·3%
Body length/head length	42	4·38	5·21	4·83	0·205	4·2%
Body length/snout to origin of 1st dorsal fin ..	40	4·06	5·09	4·51	0·206	4·5%
Body length/snout to origin of 2nd dorsal fin ..	40	1·78	2·15	1·96	0·058	2·9%
Body length/snout to origin of ventral fins ..	39	3·79	4·45	4·16	0·152	3·6%
Body length/snout to vent	39	1·68	2·06	1·98	0·067	3·4%
Body height/inter-axillary width	40	1·37	1·91	1·54	0·345	22·4%
Body length/body height at level of vent + height of 2nd dorsal fin + height of anal fin ..	38	2·03	2·92	2·69	0·156	5·8%
Body length/length of upper + length of lower caudal lobes	29	2·77	6·30	3·37	0·857	25·4%

In the above table (IV) are summarised ratios of various body proportions selected as being the more significant of those usually employed in the taxonomy of fishes. The principal variables are related either to body length (*i.e.* length from snout to caudal fork) or head length and many of the complex inter-relations used by ichthyologists are purposely omitted as being superfluous. In the above form of presentation it is easy to compare the body proportions with those of other species at a glance.

The definition of the measurements employed is to be found either in Russell, F.S. (1934), Journ. Mar. Biol. Assoc. XIX. 2, pp. 503-522 or in Cons. Internat. l'Explor. de la Mer, Rap. et Proc.—Verb., VII, 1932, pp. 47-68, and are those generally employed for Tuna. Measurement differs only in that all measurements were made with the aid of calipers and are those distances directly between the points of reference and are not made across the curvature of the body. Variation between the above series of values and those given for this species by authors from overseas can be attributed to rough measurements made from different points of reference. The body length is taken as that distance between tip of snout to posterior edge of central rays of caudal furca. Head length is that distance between tip of snout and most distant point on the free hinder edge of the operculum or gill cover. Body height is measured at level of first ray of spinous dorsal fin.

To fully define the variations met with in all of the chosen body proportions the minimum and maximum observed limits of variation are given. For complete definition of the variations shown in each proportion the Arithmetic Mean (M) and the Standard Deviation (σ) have been calculated.

The Coefficient of Variation (V) or Standard Deviation expressed as a percentage of the mean is employed here as an index to homogeneity or heterogeneity within the species. This is to be interpreted from the degree of variability of the above body proportion relationships in respect of a series of 42 examples of *S. commerson* from the east coast of Australia. Simpson and Roe, "Quantitative Zoology," 1939, have defined the normal value of V as being between the limits of 4 and 10 in a homogeneous series. It will be noted that only six of the above thirteen ratios satisfy this requirement. The lower values in four other ratios may signify that the sample is not sufficiently large to demonstrate the full range of variability and this might

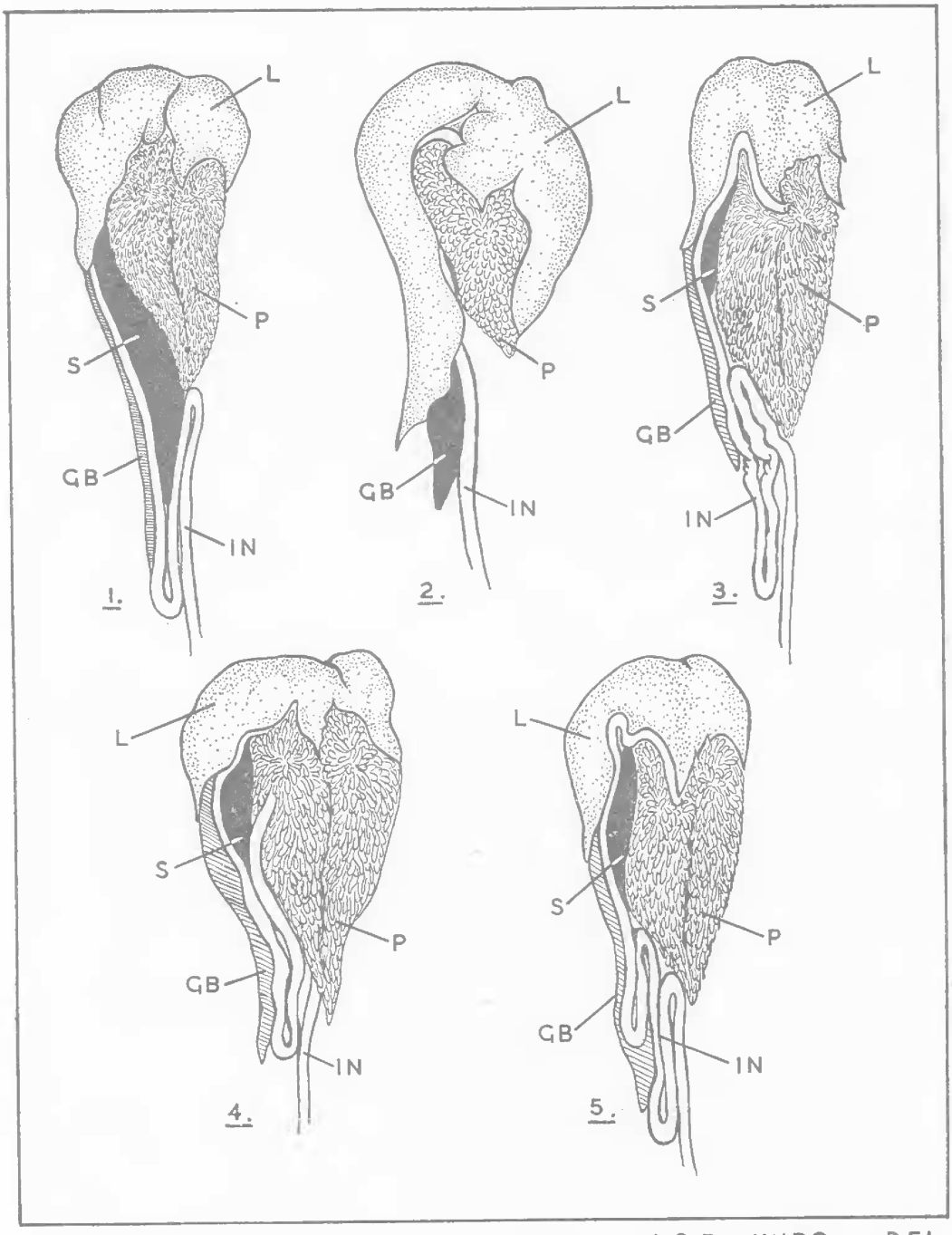
find its explanation in the fact that examples of less length than 368 mm. are not included in the above series. The higher value of 12·7 per cent. for ratio of head length/ eye diameter might not be of great significance and would appear to be insufficient to suggest racial variation. That Queensland fish are racially homogeneous is further illustrated by the fact that when any of the twenty-three part measurements defined by Russell (1934) are graphed against body length, all measurements fit along the same line. Body proportions would suggest that no racial variations of this species occur along the east coast of Australia. The higher degree of variability exhibited in the ratio of body height/interaxillary width can be interpreted as due to seasonal or sexual condition.

Body proportions of Australian examples compare fairly well with those given for this species from other world localities, namely Red Sea, Natal, Ceylon, China and Philippine Islands. Some divergence is apparent but accurate measurements for large series are required for comparison with Australian forms before it is possible to define any racial differences attributable to geographical causes.

(*e*) *Internal Anatomy.*—The liver is divided into three uneven lobes, of uniform pale brown colour and small in size compared with the mass of the pyloric caecae. The spleen and gall-bladder are long narrow organs. The lower intestine is bent upon itself in four places, thus forming four loops. The shapes and disposition of these organs is as illustrated in Text-figure 2, no. 4. Kishinouye (1923, Journ. Coll. Agric., Tokyo, VIII, pp. 410, 417) describes this fish with a swim-bladder present. I have been unable to detect any structure in Australian specimens which in any way resembles a swim-bladder. In order to search for this organ the visceral cavities of many examples have carefully been opened in the field. There is apparently no swim-bladder in the Australian race of this species. The significance of this difference is questionable. On one hand it might mean that there is a specific, or at the very least, a racial difference between the fishes of Japanese seas and those inhabiting our own coastal waters. At the same time it is quite possible that Kishinouye may have confused this structure with some loose peritoneum in his Japanese example. Apart from this difference in observation, there does not seem to be any special reason for separating these two geographical races as distinct species or even varieties.

(*f*) *Gill-rakers.*—The gill-rakers in *S. commerson* are small rudimentary structures and can have little if any functional value. They are very few in number. The upper limb of the first gill-arch has usually a single raker. This may be absent altogether and in rare cases there is a second incipient raker. There are usually 4 or 5 rakers on the lower limb of the first gill-arch in Australian examples. The most usual or average gill-raker formula can be taken as 1 + 4. The extreme variation is—upper limb = 0–2, lower limb = 3–6. The gill-arch has been illustrated by Delsman and Hardenberg (1934, Ind. Zeevisscherij en Zeevisschen, fig. 264, c.). *See also* Text-fig. 3, no. 1.

(*g*) *Lateral-line.*—The lateral-line of this species has a characteristic shape which becomes more accentuated with age, namely there is a deep inflection in the region below the second to fifth dorsal finlets. The lateral-line descends very gently and undulating only slightly until it passes the posterior end of the soft dorsal fin. It then dips very suddenly below the level horizontal with the caudal lateral keels. At the level of the fourth to fifth dorsal finlets the lateral-line has again risen to the level of the above-mentioned horizontal and follows that horizontal in an undulating



Text-fig. 2.—Arrangement and proportions of the principal components of the viscera of—

(1) *Scomberomorus* (*Sawara*) *niphonius* (Bramble Reef, North Queensland).
(2) *Grammatorcynus bicarinatus* (Watt Reef, North Queensland).
(3) *Scomberomorus* (*Indocybium*) *semifasciatus* (Townsville, Queensland).
(4) *Scomberomorus* (*Cybium*) *commerson* (North Palm Island, North Queensland).
(5) *Scomberomorus* (*Cybium*) *queenslandicus* sp. nov. (Maryborough, Queensland).

L = liver; P = pyloric caecae; S = spleen; GB = gall-bladder; IN = lower intestine.

course till it disappears in the region of the lateral keels. There are about 220 to 240 scales along the lateral-line in Queensland examples of this species. Kishinouye (1923) has given this value as 230 in Japanese specimens. It has been noticed that in the larger age groups of this species, *i.e.* examples exceeding 3 feet in length and weighing about 30 pounds, there is a vestigial branching of the main lateral-line canal. This has also been noticed by Deraniyagala (1933) in examples from Ceylon. The branch canals are quite distinct and resemble those of *Acanthocybium solandri* in structure but are restricted in length to about one quarter of an inch. They are present only in older fish. Structurally they are composed of definite tubules bordered with scales and distinctly different to the furrowing of the skin in *S. kuhlii* or *S. koreanus* and the "Pseudo-branching" effect of a scale fringed lateral-line as in *Sawara nipponia*. In *S. commerson* and *Acanthocybium solandri* there is true ramification of the main lateral canal.

(*h*) *Vertebrae.*—It has been possible to make a vertebral count in only two Australian examples of *S. commerson*. Both are from the Queensland coast and have a total of 45 vertebrae, excluding the hypural. This number is comprised of 20 precaudal vertebrae and 25 caudal vertebrae. This formula, namely 20 + 25 = 45 is identical with that given by Kishinouye (1923) for Japanese examples.

3. Synonymy.

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Scomberomorus (*Scomberomorus*) *commersoni* Deraniyagala, Ceylon J. Sci. (B), xviii, 1, 1933, p. 40, pl. I, f. 1, text-fig. 1 (Ceylon).

Scomberomorus commersonii Swain, Proc. Acad. Nat. Sc. Philad., 1883, p. 306 ; Ogilby, Rept. Dept. Harb. & Mar., Qld., 1905, p. 12 (Moreton Bay) ; Waite, Mem. N.S.W. Nat. Club, 2, 1904, p. 42 ; Jordan & Dickerson, Proc. U.S. Nat. Mus., xxxiv, 1908, p. 610 (Suva, Fiji) ; Stead, Edible

Fishes N.S.W., 1908, p. 98 (in part only—*not* pl. LXVI = *S. semifasciatus*); Roughley, Fishes Aust., Tech. Mus. Sydney, 21, 1916, p. 162; Gilchrist & Thompson, Ann. Durban Mus., i, 4, 1917, p. 395; McCulloch, Austr. Zoologist, ii, 3, 1921, p. 104, f. 292a; McCulloch, Aust. Zool. Soc. Handb. i, 1922, p. 79, f. 292a (N.S.W.); McCulloch & Whitley, Mem. Qld. Mus., viii, 2, 1925, p. 142; Whitley (in Musgrave) Austr. Zoologist, iv, 4, 1926 (Nor'West Is., Q.); Marshall "Anglers Guide," 1934, p. 36 (Qld.); Wood, Coun. Sci. Ind. Res. (Aust.) Fish Circ. 2, 1940, p. 21, pp. 40-41.

Scomberomorus konam Bleeker, Nat. Tijds. Ned. Ind., i, 1851, p. 357 (Indian Archipel.); Seale, Philip. Journ. Sci. (A), iii, 6, 1908, p. 515 (Philippines).

Cybium commersonii Saville-Kent, Food Fishes Qld., 1889, pp. 5, 10, 11, Pl. X, f. 36.

4. General Discussion on Diagnosis.—The above synonymy of *S. commerson* calls for some comment when the extent of the geographical range of this species is realised. From a thorough perusal of the published descriptions and illustrations (as listed in above synonymy), it would appear that there is but a single species referred to in this mass of world literature that has been accumulating during three centuries.

It would appear that the first published record of this species is that of Dampier (Voyage to New Holland, III, 1703, p. 162, pl. III) who briefly described and crudely illustrated "A fish of the tunny kind" from the Sharks Bay district of Western Australia. The first recognised description is that of Lacépède (1800) but it is vague and comprises part of his general description of the genus. His description is based on a drawing in the Manuscripts of that eighteenth century traveller and naturalist, Philbert Commerson. Upon this description and illustration are based those of Bloch and Schneider (1801) and Shaw (Gen. Zool., 1803). There can remain no doubt that the "Konam" of Russell (1803, Fish. Vizag., i, p. 27) and the *Scomber maculosus* of Shaw (1803) and Shaw & Nodder (1811) from Indian seas refer to this same species. That these fish are conspecific was confirmed by Cuvier & Valenciennes (1831, Hist. Nat. Poiss., VIII, p. 165) who had the opportunity of comparing material from India and Mauritius with the MS. description of Commerson, not seen by Lacépède. It was Cuvier & Valenciennes that established the fact that Commerson's fish came from Mauritius, which must therefore be considered as the type locality of *S. commerson*. As far as records show there is no type specimen preserved.

Seale (1908) Philip. Journ. Sci, (A), iii, 6, p. 515, holds that *S. konam* and *S. commerson* are distinct species and that both occur in the Philippine waters. This is apparently based on the views of Bleeker, who consistently held that both species occurred in Indian and East Indian seas. However, as careful examination of Bleeker's original latinised description of *Cybium konam* (Nat. Tijds. Ned. Ind., i, 1851, p. 357) reveals that it fits in all details the body proportions, colour and fin-formulae of *S. commerson*, there remains little justification for considering these separate species. Until such time as someone can show just where *S. konam* and *S. commerson* differ, it is only reasonable to consider them conspecific.

As the distribution of this species is so large it is quite probable that several geographical races exist, but it is impossible to detect significant differences from the descriptions of *S. commerson* from the various regions of its distribution. The fish from the Red Sea as described by Rüppell (1828, 1835) and Klunzinger (1871, 1884) fit well enough the above description of the Australian form. Likewise do the descriptions and figures of this species from S.E. Africa and Indo-Japanese waters. Regarding the Indian form I have seen only two specimens which can be identified as this species, namely two immature fishes from Madras. These are in the Australian

Museum collection (B. 8208, "*C. commersonii*" & B.8116, "*S. guttatus*") and apparently were purchased from Mr. Francis Day. Both examples are undoubtedly of the same species and resemble our local *S. commerson* in respect to all principal characters and individualities.

Of Australian identifications, most appear to refer to a single species and most diagnoses are correct. A few have been confused with *S. semifasciatus*, especially young specimens. Fin formulae and gill-raker counts are always sufficient for distinguishing between these two species. For purposes of comparison a young specimen of *S. commerson* is illustrated in Plate VIII. The specimens in the Australian Museum that are identifiable as *S. commerson* are I.9693 (Pt. Jackson, upon which apparently is based the first description of an Australian specimen by Macleay, 1881), B.584 (Pt. Jackson), IA.5679 (E. Papua), I.14566 (Cooktown). Two specimens of small size (IA.7669, IA.7670) from Northern Territory collected by M. Ward and four very immature examples (I.5296-I.5299) from Darwin, N.T. though labelled "*S. commerson*" have been wrongly identified—all are typical *S. semifasciatus*. One other example (I.15275) is apparently that figured by Stead (1908, Ed. Fish N.S.W., pl. LXVI) and is another typical *S. semifasciatus*.

SCOMBEROMORUS (CYBIUM) QUEENSLANDICUS sp. nov.

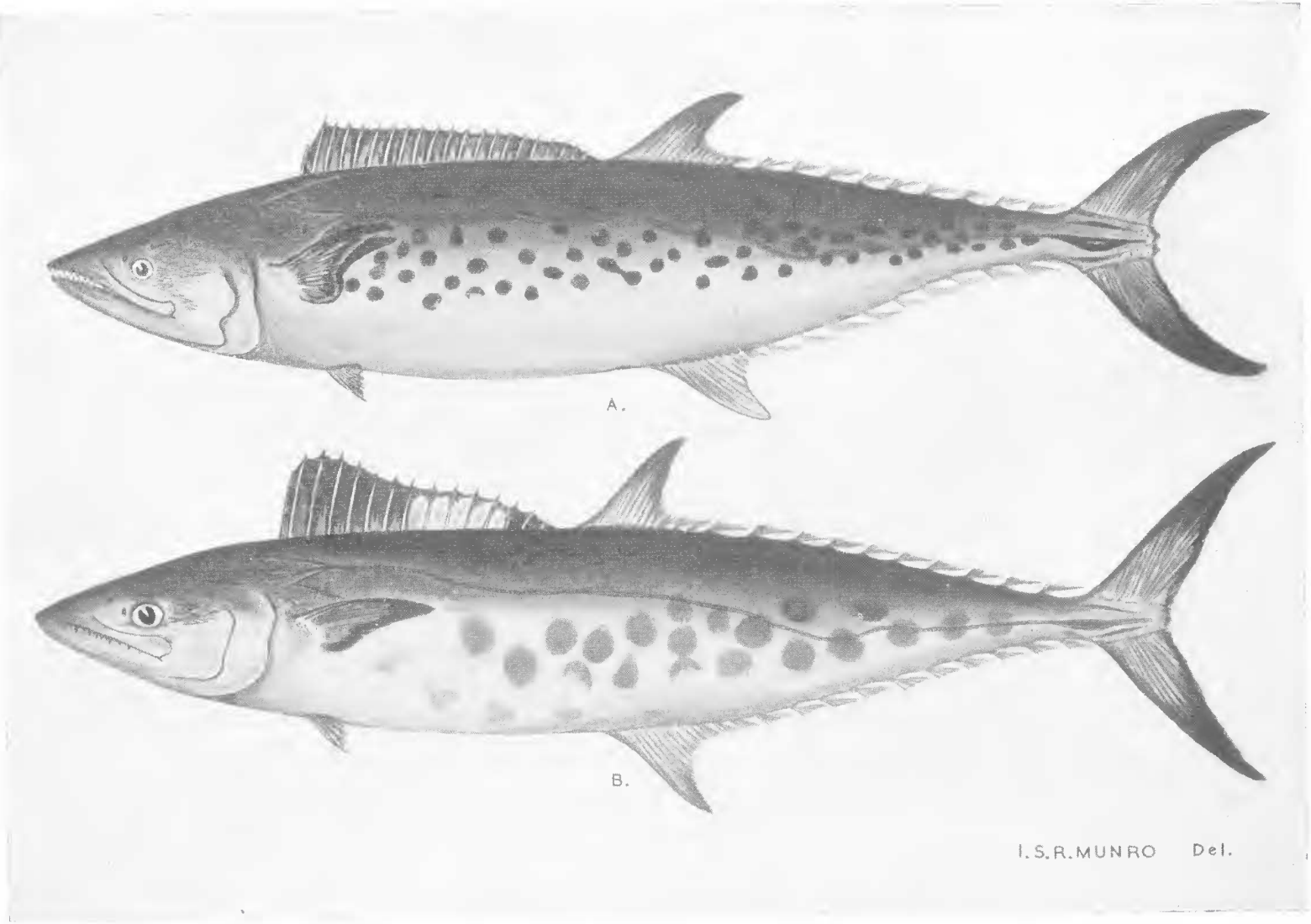
QUEENSLAND SCHOOL MACKEREL.

Plates VII & VIII.

1. Distribution.—This species, though new to science, is very common along the Queensland coast. It occurs along the West Australian coast also. It is essentially an estuarine fish caught by nets and by trolling in all the inlets between Brisbane and Townsville. The range of this species is probably greater and there is evidence to suggest that Macleay's specimen identified as *C. guttatum* from Pt. Jackson belongs to this species. It has been known to South Queensland fishermen for over sixty years as "School Mackerel" and has been sold in the Brisbane Fish Markets as such ever since their foundation. A skeleton with descriptions and an illustration supplied by Mr. J. Gregory confirms the existence of this species in West Australian waters. Mr. Gregory's record refers to Sharks Bay. There is no data available for Northern Australia. It is safe to consider the geographical distribution as being the East and West coasts of Australia between the latitudes of 10° S. and 30° S. No species identifiable as this is known from overseas.

2. Description.—(*a*) *Size.*—This species apparently reaches maturity at small size. It is the smallest of Australian Scomberomoridae. Examples of about 500 mm. length and weighing 3 or 4 pounds are average size. The age groups normally caught in Queensland waters vary from 300 mm. to about 750 mm. in length and these probably represent at least three age groups.

(*b*) *Colour.*—In freshly caught specimens the colours are as follows:—Cranial regions and upper part of the back are an iridescent bluish green and the cheeks and belly are a silvery white. In adult fish the sides are marked with about three indefinite rows of bronze-grey indistinct blotches, each a little larger than the orbit. The membrane of the spinous dorsal fin is jet black with large contrasting areas of intense white between the sixth and last spines. The second dorsal fin and the finlets are pearly grey with darker margins. The caudal fin is of similar colour. The ventrals, anal fin and anal finlets are white. The pectoral fins are greyish, being darkest on their inner surface.



Australian Spanish Mackerel.

Fig. A.—*Scomberomorus (Sawara) niphonius* (Cuv. & Val.), Spotted Spanish Mackerel. Specimen from Mackay district, North Queensland, 26th September, 1941. Length to caudal fork = 795 mm.

Fig. B.—*Scomberomorus (Cybium) queenslandicus* sp. nov., School Mackerel or Blotched Spanish Mackerel. Specimen from Moreton Bay, South Queensland, 25th July, 1942. Length to caudal fork = 545 mm.

Apparently the body markings alter with age. A small example of 95 mm. length is included in the Queensland Museum collection (Reg. No. I.7073) and this lacks the bronze-grey blotches of older fish. There are no markings on the belly, but along the back (*see* Plate VIII) are about twelve broken bars of a greyish colour. This growth change of colour pattern contrasts strongly with the constancy of markings in *S. semifasciatus* where the markings change but little with age.

(*c*) *Fin formulae.*—The fin formula is almost the same as that of *S. commerson.* This makes it difficult to separate the two species in old museum specimens from which the markings have faded. The range of variation in fin counts is shown in the following frequency table (V) :—

TABLE V.—FIN COUNTS IN *S. queenslandicus.* SERIES FROM QUEENSLAND WATERS.

No. of Spines and rays.	9	10	15	16	17	18	19	20	21	22	23	Total Number of Individuals.
1st Dorsal			1	16	6							23
2nd Dorsal				2	6	9	4	2				23
Dorsal Finlets	9	12										21
Anal			1	0	2	6	9	4				22
Anal Finlets	9	12										21
Pectoral								1	10	10	1	22

From the figures shown in Table V it is possible to define the range of variation in the principal fins as :

D, 15-17 ; 16-20 ; 9-10. A, 15-20 ; 9-10. P, 20-23.

The average fin formula (*i.e.* modal) can be taken as :—

D, 16 + 18 + 10. A, 19 + 10. P. 21-22.

This formula differs significantly from that given for *S. commerson* only in that there are on the average a few more rays in the anal fin of this species, *i.e. S. queenslandicus* = 19, and *S. commerson* = 17. It is almost impossible in practice to separate these two species on the basis of fin formulae alone. The shape of all fins are similar and normal in both species.

(*d*) *Body proportions.*—

TABLE VI. : BODY PROPORTIONS OF *Scomberomorus queenslandicus.* SERIES FROM EAST COAST OF AUSTRALIA—TOWNSVILLE TO PT. JACKSON. SIZE RANGE (L.C.F.) 288mm. TO 601mm.

Ratio.	Number of Specimens.	Observed Range.		Mean.	σ	Coefficient of Variation.
		Minimum.	Maximum.			
Head length/snout length	21	2·40	2·85	2·50	0·133	5·3%
Head length/eye diameter	21	5·25	8·41	7·33	1·036	14·2%
Head length/inter-orbital	21	2·74	3·31	3·05	0·175	5·7%
Head length/maxilla length	21	1·68	1·80	1·74	0·031	1·8%
Head length/pectoral fin length	21	1·58	2·22	1·79	0·161	8·9%
Body length/head length	21	4·25	5·09	4·55	0·240	5·3%
Body length/snout to origin of 1st dorsal fin	21	4·12	4·49	4·11	0·216	5·3%
Body length/snout to origin of 2nd dorsal fin	21	1·93	2·08	1·99	0·047	2·3%
Body length/snout to origin of ventral fin	18	3·93	4·35	4·11	0·110	2·7%
Body length/snout to vent	20	1·85	2·09	1·98	0·059	2·9%
Body height/inter-axillary width	12	1·48	2·00	1·74	0·129	7·4%
Body length/body height at level of vent + height of 2nd dorsal fin + height of anal fin	20	2·43	2·86	2·61	0·103	3·9%
Body length/length of upper + length of lower caudal lobes	10	2·72	3·31	3·09	0·156	5·0%

For comparison of the body proportion ratios of *S. commerson* and *S. queenslandicus* reference is made to Tables IV and VI respectively. It will be noted

that all the ratios show a close similarity in each species. This similarity gives support for the inclusion of the two species in the same subgenus, namely *Cybium* J. & H. The ratios are hardly sufficiently dissimilar to be used as indices by which to separate the two species, but there are some significant differences between certain of these ratios in subgenus *Cybium* and *Scomberomorus* (*Indocybium*) *semifasciatus*. Of the slight differences between *S. commerson* and *S. queenslandicus* it can be noted that :—

(1) The snout is slightly shorter than in *S. commerson*.
(2) The eye diameter larger than in *S. commerson*.
(3) First dorsal fin inserted slightly further back than in *S. commerson*.
(4) The caudal fin very slightly larger than in *S. commerson*.

It can be seen that some of the values for Coefficient of Variation are rather low, *i.e.* less than 4. This condition is comparable to that exhibited by *S. commerson*. The significance may not be as great as Simpson and Roe have indicated. As suggested by Serventy (1942, Journ. Coun. Sci. Ind. Res. (Aust.), xv, 2, p. 104) the possession of a low intrinsic variability by some ratios might be interpreted as signifying that the magnitude of these is remarkably constant. Their values would therefore be useful as specific characters. With the exception of the ratio head length/eye diameter, all coefficients of variation have a value of less than 10. This would suggest that the material comprising this series is quite homogeneous. From this examination of body proportion ratios it can be concluded that there is no indication of the existence of local races or varieties of this species of Spanish Mackerel.

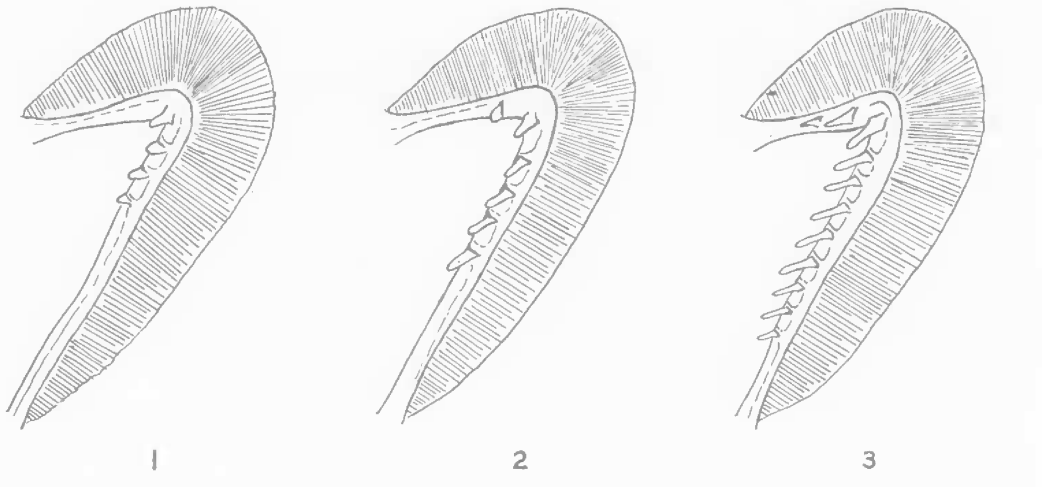
(*e*) *Internal Anatomy.*—It is also difficult to tell the difference between *S. queenslandicus* and *S. commerson* with reference to the internal anatomy only. The liver, spleen and gall-bladder have much the same shape and proportions in both species. The liver is tri-lobed as in other species of the genus. The lower intestine has four loops as in *S. commerson* but in this respect differs from *S. semifasciatus* and *S. niphonius*. This character may have subgeneric significance. The stomach bag has usually 12 folds on its inner surface. There does not appear to be any swim-bladder. The viscera is illustrated in Text-figure 2, No. 5 (young specimen).

(*f*) *Gill-rakers.*—The gill-rakers are short processes but not quite such rudimentary structures as found in *S. commerson*. Their number is slightly greater. As in other species this number is subject to variation. On the upper limb of the first arch there is at most one rudimentary raker and this is very often altogether absent. There may be from 4 to 7 short rakers on the lower branch of the first arch but 5 or 6 is more usual. The gill-raker formula is thus $0 + 4$ to $1 + 7$ and $0 + 6$ is very common. The first gill-arch (left) is illustrated in Text-figure 3.

(*g*) *Lateral-Line.*—As a general rule the lateral-line is not very wavy and lacks the deep inflection under the first four dorsal finlets possessed by *S. commerson*. It descends gently to a point beneath the first two or three dorsal finlets and then pursues a horizontal course to the caudal peduncle. The lateral-line is not branched and is composed of a variable number of scales, the number of which seems to vary from about 180 in young examples to about 220 in older age groups.

(*h*) *Vertebrae.*—Examination of the skeletons of nine specimens from the east coast of Australia reveal that in eight of these there are $20 + 28 = 48$ vertebrae. The ninth has $20 + 29 = 49$. The average count for the eastern Australian fish can be taken as being 48 vertebrae comprising 20 precaudal vertebrae and 28 caudal

not including the hypural joint. The only specimen that I have seen from Western Australia (Sharks Bay) shows a slight variation in this count—not in the total count, but there is one less precaudal vertebra and one more caudal vertebra, *i.e.*



Text-fig. 3.—Gill arches showing gill-rakers in three species of Spanish Mackerel—
(1) *Scomberomorus* (*Cybium*) *commerson* (Lacépède).
(2) *Scomberomorus* (*Cybium*) *queenslandicus* sp. nov.
(3) *Scomberomorus* (*Indocybium*) *semifasciatus* (Macleay).

19 + 29 = 48. This slight variation may be significant in that it might indicate the existence of two races of this species, one from the east coast and the other from the west. It would be foolish to conclude this from such little material.

3. Comparison with Other Species.—For the purposes of general comparison of the principal morphological features of this species with those of other known world species, Table I should be referred to.

The possession of 16 spines in the first dorsal fin, broad flat minutely serrulate teeth and a restricted number of gill-rakers of a rudimentary type is sufficient to separate this new species from all other known valid species in the world with the exception of *S. commerson*. The possession of this particular combination of characters enables us to set apart these two species (*S. commerson* and *S. queenslandicus*) in a distinct subgenus *Cybium* J. & H. Further, *S. queenslandicus* can be distinguished from *S. commerson* as follows :—

Table VII. Differences in principal characters of *S. commerson* and *S. queenslandicus*.

Character.	*S. queenslandicus.*	*S. commerson.*
1. Vertebral count	20 + 28 = 48	20 + 25 = 45
2. Markings	About three rows of diffuse blotches.	Numerous wavy vertical bands on belly.
3. Lateral-line	Not deeply inflected.	Deep inflection below 2nd & 3rd dorsal finlets.
4. Anal fin count	17-20. mode at 19.	16-18, mode at 17.
5. Gill-rakers	Normal = 1 + 6.	Normal = 1 + 4.

4. General Discussion on Diagnosis.—Although new to science, this species has not altogether escaped the notice of Australian ichthyologists but in the past has been erroneously identified. It has been confused with the young of *S. commerson* and even with *S. semifasciatus*. In most cases it has passed under the name of *S. guttatus* (Bloch & Schneider). *Scomberomorus guttatus* is a form restricted in distribution to India and the Indian Archipelago and does not resemble *S. queenslandicus* very closely but is more like our *S. semifasciatus*. The true *S. guttatus* does not occur in Australian waters and must be struck off all our Australian Check Lists of Fishes. Its synonymy is rather confused, principally with *S. queenslandicus* and *S. kuhlii* (C. & V.). True *S. guttatus* is that described and figured by Bloch & Schneider (1801, Syst. Icth.), Russell (1803, Fish. Vizag., II), Cuvier and Valenciennes (1831, Hist. Nat. Poiss, VIII), Day (1876, Fish. India), Maxwell (1921, Malayan Fish.) and Delsman & Hardenberg (1934, Ind. Zeevisscherij en Zeevisschen, fig. 274). Other descriptions are questionable. The *S. guttatus* of Kishinouye (1923 Journ. Coll. Agric. Tokyo) and Deraniyagala (1933, Ceylon J. Sci. (B), xviii) belong to the similarly spotted Indo-Japanese *S. kuhlii* C. & V. True *S. guttatus* has about five rows of smaller spots, 2 + 11 gill-rakers and has much the same body proportions as *S. semifasciatus*, namely small head, large tail and predominant dorsal and anal fins. Morphologically it is quite unlike *S. queenslandicus*.

Rendahl's *S. guttatus* is not *S. queenslandicus* but unquestionably *S. semifasciatus* (K. Svenska, Vet. Akad. Handl., LXI, 9, 1923, W. Australia). The specimen described by Macleay (1881, Desc. Cat. Aust. Fish., p. 193) from Port Jackson is apparently *S. queenslandicus*, as are also the fish described by Stead (1908, Edible Fish. N.S.W.), (1906, Fish. Aust.). The example (I.15026) presented by Stead to the Australian Museum and labelled "*S. guttatus*" is a typical *S. queenslandicus*, as are also the following specimens in the collection of that institution—IA.56, IA.1598 from Cairncross Is., I.15276, and IA.6573, from Cumberland Grp. Of the series in the possession of the Queensland Museum the following are typical *S. queenslandicus*:—I.5994 from Moreton Bay, I.6580, I.6588 from C. Cleveland, N. Qld., and I.7266 from Moreton Bay.

5. Type Specimen.—The holotype has been selected for convenience from the series in the Queensland Museum Collection. The holotype is thus designated as specimen, Qld. Mus. Reg. No. I.6588 from Cape Cleveland, North Queensland. This specimen was collected and presented to the Museum by Mr. G. Coates of Townsville. This example measures 464 mm. Its fin formula is D. 17 + 19 + 9; A. 20 + 9; P. 22. Gill-rakers 0 + 6. Scale row (lateral-line) = 180. Teeth—upper jaw = 34, lower jaw = 20. Length of head = 101 mm.; length of snout = 42 mm.; diameter of eye = 13 mm.; length of maxilla = 59 mm.; interorbital distance = 36 mm.; height at level of anus = 83 mm.; length of pectoral fin = 57 mm.; height of first dorsal spine = 28 mm.; height of soft dorsal fin = 52 mm.; height of anal fin = 50 mm.

SCOMBEROMORUS (SAWARA) NIPHONIUS (Cuvier & Valenciennes) 1831.

SPOTTED or JAPANESE SPANISH MACKEREL.

Plate VII.

1. Distribution.—That this species occurs in Queensland waters has never before been appreciated nor put on record by ichthyologists. However it is quite well known from the seas of China and Japan. As far as records show the distribution in the Northern Hemisphere is roughly limited by the parallels of 25° N. and 45° N.

along the coast of China, Korea, and both coasts of Japan. In Australian waters the known limits are 18° S. to 30° S. approximately and restricted to the east coast *i.e.* from Palm Is., N. Qld. to Coff's Harbour, N.S.W. It is caught principally in shallow waters over reefs close inshore but has also been caught along the Great Barrier Reef. It is fished in small numbers on North Queensland fishing grounds from October onwards but in larger numbers in South Queensland and northern N.S.W. from December until April and May.

2. DESCRIPTION.—(*a*) *Size.*—The examples of this species which I have examined vary in length (*i.e.* snout to caudal fork) from 56 cm. to 101 cm. The average run is of 70-90 cm. in length and weighing from 7 to 10 lb. There are apparently several age groups represented in the catches of fishermen along this coast. Generally speaking the examples of this spotted species are larger in size than those of the other Australian spotted species *S. queenslandicus.*

(*b*) *Colour.*—In freshly caught specimens the colours are as follows :—Cranial regions and upper part of back are of a darkish blue. The sides are a light silvery grey marked with three or four indefinite rows of dark grey spots along the region of the lateral line. These spots are rounded or irregular in shape and about the size of the pupil of the eye (ca. $\frac{3}{8}$-$\frac{1}{2}$ in. diameter). The cheek plates and belly are of silvery white. There is a pale but distinctive purplish sheen over most of the body of freshly caught fish and this is especially noticeable on the belly. The spinous dorsal is of a bright steely blue with a mottling of white throughout. There are white blotches on the membrane near the bases of the more posterior spines while there are areas of darker grey near the tips of the spines. The second dorsal fin and dorsal finlets are of a dull grey as also are the caudal flukes. Anal fin is light silvery grey with white near its tip. Anal finlets are silvery grey. Inside surface of pectoral fin is dark blue as on back and outer surface dark silver grey. Ventral fins silver white internally but greyish on the outside. The body colours lose their brilliance and fade to various shades of grey after death.

(*c*) *Fin Formulae.*—Not a great deal of material has been available for this study but a fairly good idea of the range and variation of fin counts in Australian specimens can be gleaned from the following table (VIII) :—

TABLE VIII : FIN COUNTS OF *Scomberomorous niphonius.* SERIES FROM QUEENSLAND COAST.

No. of spines and rays.	9	10	15	16	17	18	19	20	21	22	23	Total Number of individuals.
1st Dorsal								7	8	1		16
2nd Dorsal				2			1					3
Dorsal Finlets	2	1										3
Anal			1		1	1						3
Anal Finlets	3											3

The fins have a range of variation in respect to number of constituent spines according to the following formula :—

D, 20-22 + 16-19 + 9-10 ; A, 15-18 + 9. P, 23.

This formula compares well enough with that given in the descriptions of this species (*S. niphonius, S. gracilis*) by other authors. For comparison Table IX is

included setting out these counts as extracted from the classical descriptions of this fish :—

TABLE IX. FIN COUNTS OF *S. niphonius* AND *S. gracilis* FROM CHINA AND JAPAN.

—	D_1	D_2	Dorsal Finlets.	A.	Anal Finlets.	P.	Authority.	Locality.
C. gracile ..	20	16	9	18	8		Günther 1873	Chefoo
S. gracilis ..	20		8	17	8		Tortonese, 1939	Yokohama
C. niphonium	20	16	8	14	8		Temminck & Schlegel, 1850. Günther, 1860	Japan
C. niphonium	20	16	8	17	8	21–23	Tanaka, 1912	Japan
C. niphonium	19	15	9	15–17	8		Kishinouye, 1923	Japan
C. niphonium	20	16	8	16	8–9		Fowler, 1936	Japan

Of the fins, the spinous dorsal calls for special comment. It is relatively long, low and its upper edge almost straight. The abnormally large number of spines (usually 20 or 21) makes it easy to distinguish this species from all other Scomberomorids. It is this feature in particular that calls for the separation of *Sawara* as a separate subgenus.

The pectoral fin has also a distinctive shape in that the posterior margin is deeply excised forming two distinct lobes. This feature is more pronounced than in any other known species of *Scomberomorus*.

(*d*) *Body proportions.*—Data on body proportions is available for one specimen only. It is impossible therefore to indicate the range of variation, or define it in terms of the mean and standard deviation, for the recognised ratios. The following table (X) is given for comparison of the body proportions of a single Australian example (from Mackay) with those given for Sino-Japanese specimens in the various published descriptions.

TABLE X. BODY PROPORTIONS OF AN AUSTRALIAN EXAMPLE OF *Scomberomorus niphonius* (795mm.) COMPARED WITH THOSE OF SINO-JAPANESE SPECIMENS.

Ratio.	Qld. (Mackay).	*S. niphonius.*			*S. gracilis.*
		Temminck & Schlegel 1884.	Tanaka 1912.	Fowler 1936.	Tortonese 1939.
Body length/head length	5·49	5·0	4·7	4·0–4·2	5·0
Body length/body height	5·56	5·5	5·12	4·75–5·0	6·0
Head length/snout length	2·42		2·5	2·9–3·0	
Head length/eye diameter	9·88		7·75	4·0–5·0	7·0
Head length/maxilla	1·87		1·8	1·75–1·8	
Head length/pectoral fin	1·92		2·2	1·8–2·0	2·0
Head length/height of 2nd dorsal fin	1·70		2·4	2·75–3·0	
Head length/height of anal fin	1·72		2·9	2·8–3·0	
Head length/inter-orbital	3·22		3·0	4·0–4·12	

In addition to the above series of ratios of body proportions the following list is added. These refer to this single Queensland example :—

Body length/snout to origin of 1st dorsal fin	4·81
Body length/snout to origin of 2nd dorsal fin	1·92
Body length/snout to origin of ventral fins	4·20
Body length/snout to vent	1·91
Body length/length of upper + lower caudal lobes	3·24
Head length/snout to hinder edge of preopercle	1·11
Body height/interaxillary width	1·87

From the above series of values listed in table X, it is obvious that there is no significant departure from those given for Japanese examples of *S. niphonius*. Admittedly there is a difference in respect to the ratio of head length/eye diameter, but this value would depend largely on the manner in which the eye was measured. The height of second dorsal and anal fins are those recommended by Russell and the International Council (*loc. cit.*), but those given by Tanaka and Fowler presumably refer to the perpendicular heights from tip of fin to insertion with body flesh. They are necessarily smaller.

Interpretation of the body proportion ratios would suggest that the Queensland examples are sufficiently similar as to be conspecific with *S. niphonius* or *S. gracilis* of Chinese and Japanese seas.

(*e*) *Internal Anatomy.*—Liver tri-lobed with right lobe predominating in respect to length. The middle lobe appears to be divided into two smaller lobes. Both gall-bladder and spleen are longer and larger than in subgenera *Cybium* or *Indocybium*. As in *Indocybium semifasciatum* there are only two loops in the lower intestine. The general proportions are as illustrated in Text-fig. 2, No. 1. There is no swim-bladder as also noted by Kishinouye (1923).

(*f*) *Gill-rakers.*—In the only Queensland specimen examined the number of gill-rakers was found to be :—Upper limb of 1st arch—2 ; Lower limb of 1st arch—9. This value of 2 + 9 is slightly less than that given for Japanese specimens, namely 2 + 10, 3 + 11 and 3 + 9 or 10 but is sufficiently similar.

(*g*) *Lateral line.*—The lateral line as already described for subgenus *Sawara* is simple and not branched as reported by Kishinouye. There is a band of enlarged scales along each side of the lateral line and this admittedly sometimes gives the appearance of vestigial branching of the main canal. There is no true branching in Queensland specimens. The lateral line is wavy throughout its whole length and slopes gradually from its origin above the pectoral fin to the point where it finishes in the region of the tail. There are no deep inflections throughout its course. It is composed of about 210 scales.

(*h*) *Preopercle.*—The shape of the preopercle is sufficiently characteristic of the species as to warrant special mention. The postero-ventral margin is, like the pectoral fin, deeply excised and very noticeable as is evident from a glance at Plate VII, fig. A.

(*i*) *Vertebrae.*—I have no data for Australian specimens. Kishinouye gives the number as 22 + 28 in Japanese examples.

3. Synonymy.

Cybium niphonium Cuvier & Valenciennes, Hist. Nat. Poiss., viii, 1831, pp. 180-181 (after a Japanese painting) ; Richardson, Rept. 15th meet. Brit. Assn. Adv. Sci., 1846, p. 268 (Japanese seas) ; Bleeker, Verh. Bat. Gen. xxv, 1853, p. 14 (Japan) ; Bleeker, Verh. Bat. Gen, xxvi, 1856, p. 50 (Japan) ; Günther, B.M. Cat. Fish., ii, 1860, p. 371 ; Bleeker, Verh. Nat. Kon. Akad. Amsterdam. xviii, 1878, p. 15 (Japan) ; Günther, Rept. Challenger Voy., Shore Fishes, 1880, p. 66 (Inland Sea, Japan) ; Peters, Monatsb. Akad. Wiss., Berlin, xvi, 1881, p. 922 (Ningpoo) ; Temminck & Schlegel, Fauna Japonica, Pisces, 1884, p. 101, pl. LIII, f. 2 (Nagasaki) ; Kishinouye, Sui. Gak. Ho, i, 1915, p. 10, pl. I, f. 4 ; Kishinouye, Journ. Coll. Agric., Tokyo Univ., viii, 3, 1923, p. 421, figs. 6, 9, 32, 41 (N. China & Japan).

Cybium niphonicum (Error) Kner, Reise Novara, I, 5, 1869, p. 144.

Cybium gracile Günther, Ann. Mag. Nat. Hist., (4), xii, 1873, p. 378 (Cheefoo) ; Günther, Ann. Mag. Nat. Hist., (7), i, 1898, p. 260 (Newchang, N. China) ; Fowler, Hong Kong Nat., vii, 1, 1936, p. 73.

Scomberomorus niphonius Tanaka, Fishes Japan. ix, 1912, pp. 154-157, pl. XLII, f. 163-164, pl. XLIV, f. 173 (Tokyo) ; Jordan, Tanaka & Snyder, Journ. Coll. Sci., Univ. Tokyo, xxxiii, 1913, p. 121 (Japan) ; Jordan & Metz, Mem. Carneg. Mus., vi, 1, 1913, p. 26 (Fusan) ; Sowerby, Naturalist in Manchuria, iv, 1930, p. 197 (Pei tai Ho) ; Uda, Bull. Jap. Soc. Sci. Fish., i, 1932, pp. 124-129 ; Tanaka, Fishes Japan, 1936 abridged Popular ed., p. 146 ; Fowler, Hong Kong Nat., vii, 1, 1936, pp. 73-74, fig. 7 ; Tanaka, Jap. Fishes in life colours, pl. 132 (text in Japanese) ; Herre, 6th Pacif. Sci. Congress, Oceanogr., 1940, p. 213.

Scomberomorus gracilis Tortonese, Boll. Mus. Zool. Anat. Comp., Torino, xlvii (3), 100, 1939, pp. 321-322, pl. IX, f. 1.

Scomberomorus gracileus (Error) Chu, Biol. Bull. St. Johns Univ., i, 1931, p. 107.

Sawara niphonia Jordan & Hubbs, Mem. Carneg. Mus., x, 2, 1925, p. 214 (Kobe) ; Chu, Biol. Bull. St. Johns Univ., i, 1931, p. 107.

4. General Discussion on Diagnosis.—There may remain a little doubt as to whether Australian specimens belong to the same species as those from Japanese and Chinese waters. The break in the geographical distribution might suggest specific distinction, but making allowances for minor variations, the morphological differences between Australian and Japanese examples is not great. Markings, colouration, gill-raker counts, body proportions, shape of pectoral fin and preopercle indicate synonymy. It is possible that the nature of the lateral-line may prevent these two species from being conspecific. Although the lateral-line is reputed to be branched in oriental specimens, there is no evidence of such branching in examples caught in Queensland waters. This character apparently is of some importance since Jordan & Hubbs (1925) used this feature to separate their subgenus *Sawara*. At the same time it is well worth noticing that Tortonese (1939) reinstated Günther's name "*gracilis*" for application to an oriental specimen which lacked branching of the lateral-line. As stated earlier, it is very probable that the branching of the lateral-line is not as noticeable or as regular as described by Kishinouye and followed by later authors. Australian examples fit well enough the descriptions and resemble in the main essentials the illustrations of Cuvier & Valenciennes (1831), Günther (1860, 1873), Temminck & Schlegel (1884), Tanaka (1912), Kishinouye (1923), Fowler (1936) and Tortonese (1939). As already suggested in the description of the subgenus *Sawara*, there appears to be insufficient justification for considering *S. niphonius* and *S. gracilis* separate species. Also, it is reasonable to accept that the Australian form is similarly conspecific.

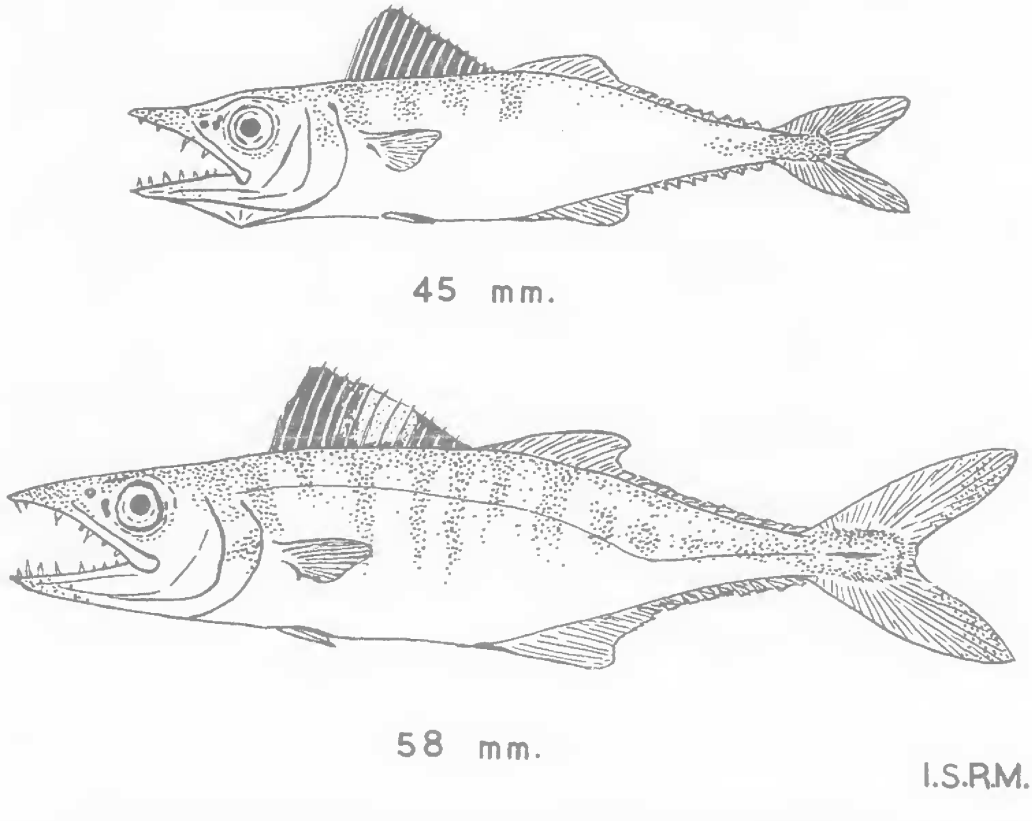
This species is readily distinguishable in the field by the long spinous dorsal fin, the excised pectoral fin and preopercle and the body covering of comparatively large scales.

It is possible that some of the records of "*C. guttatum*" in Australian fish literature may refer to this species, but more likely the majority refer either to *S. semifasciatus* or *S. queenslandicus*. There are no specimens of this species in Australian Museums.

SCOMBEROMORUS (INDOCYBIUM) SEMIFASCIATUS (Macleay) 1883.
BROAD-BARRED SPANISH MACKEREL.

Plates VI and VIII; Text-Fig. 4.

1. DISTRIBUTION.—This species is limited to Australian waters. It is not well-known. Records indicate that the distribution is limited to the tropical and semi-tropical coastal waters of Queensland and Northern Australia. No adequate data is available from Western Australia. Macleay's type specimen comes from the Burdekin River, Nth. Queensland and De Vis' holotype (*i.e. C. tigris*) from Cape York. I have seen and examined innumerable specimens from the Queensland coast from Moreton Bay in the south to Townsville in the north. There are specimens (I.5296-9, IA.7669 and IA.7670) in the Australian Museum collection to confirm that the distribution extends into the Northern Territory at least as far as Darwin. Rendahl's (1921)



Text Fig. 4.—Immature specimens of *Scomberomorus* (*Indocybium*) *semifasciatus* (Macleay), from Townsville, North Queensland. Lengths to caudal fork = 45 mm. and 58 mm. respectively. The body markings are as in adult fish.

specimen of "*C. guttatum*" = *S. semifasciatus* enables us to further extend the range westwards to Broome in N.W. Australia. A head and tail (I.6323-4) in the Queensland Museum collection indicates that the distribution also stretches northward into the Torres Straits (Thursday Is. and Coconut Is.). The distribution can be summed up as Australian coastal waters within the limitations set by the parallels of 10° S. and 30° S. latitude.

2. DESCRIPTION.—(*a*) *Size.*—Published descriptions of this species deal only with small specimens. Examples of 1000 mm. (ca. 40 inches) are not uncommonly

seen in Brisbane Fish Markets. Fish of 600 mm. to 900 mm. are caught on the fishing grounds north of Yeppoon in November while smaller age groups are caught in the estuaries along the Queensland coast north of Moreton Bay. Immature stages ranging in size from 4·5 to 10·0 cm. (*see* Text-fig. 4) are common along the beaches in the vicinity of Townsville during the month of November and grow to twice this size by January. Examples measuring 300 to 400 mm. are probably one year old.

(*b*) *Colour.*—In immature specimens (*i.e.* less than 100 mm.) the colouration in life is as follows :—Cranial regions and upper regions of the back are pale green with a bronze sheen and marked with about twelve to twenty broad vertical bands of a dark grey. These bars are confined to the region of the body above the lateral-line and their number increases with age. The cheeks and belly are silvery white. The snout is a dark slate grey and there is a patch of green above the orbit. The spinous dorsal fin is jet black with contrasting areas of white in its central region. The second or soft dorsal fin is cream with yellow anteriorly. The anal fin and all finlets are of a transparent white. The caudal flukes are creamy white at their margins and dusky or blackish near the hypural. The pectoral fins are dusky.

As the species increases in size the bronze-green colouration of the back turns to a greenish blue. The vertical bands on the back are most marked in specimens less than 500 mm. length and in larger fish there is a tendency for these markings to become less distinct, break into spots or fade out more or less completely. Above 700 mm. dead fish assume a drab greyish-yellow blotchy appearance with little or no evidence of markings. This uniform grey colour apparently accounts for the vernacular " Grey Mackerel " of Queensland fishermen as applied to older age groups of the species. The younger age groups caught in the Queensland estuaries principally Moreton Bay and Hervey Bay are called " Brownies " or even " Striped School Mackerel."

(*c*) *Fin Formulae.*—Not very much material has been available for this determination but an idea of the range of variation of the various fin counts can be gleaned from the following table (XI) :—

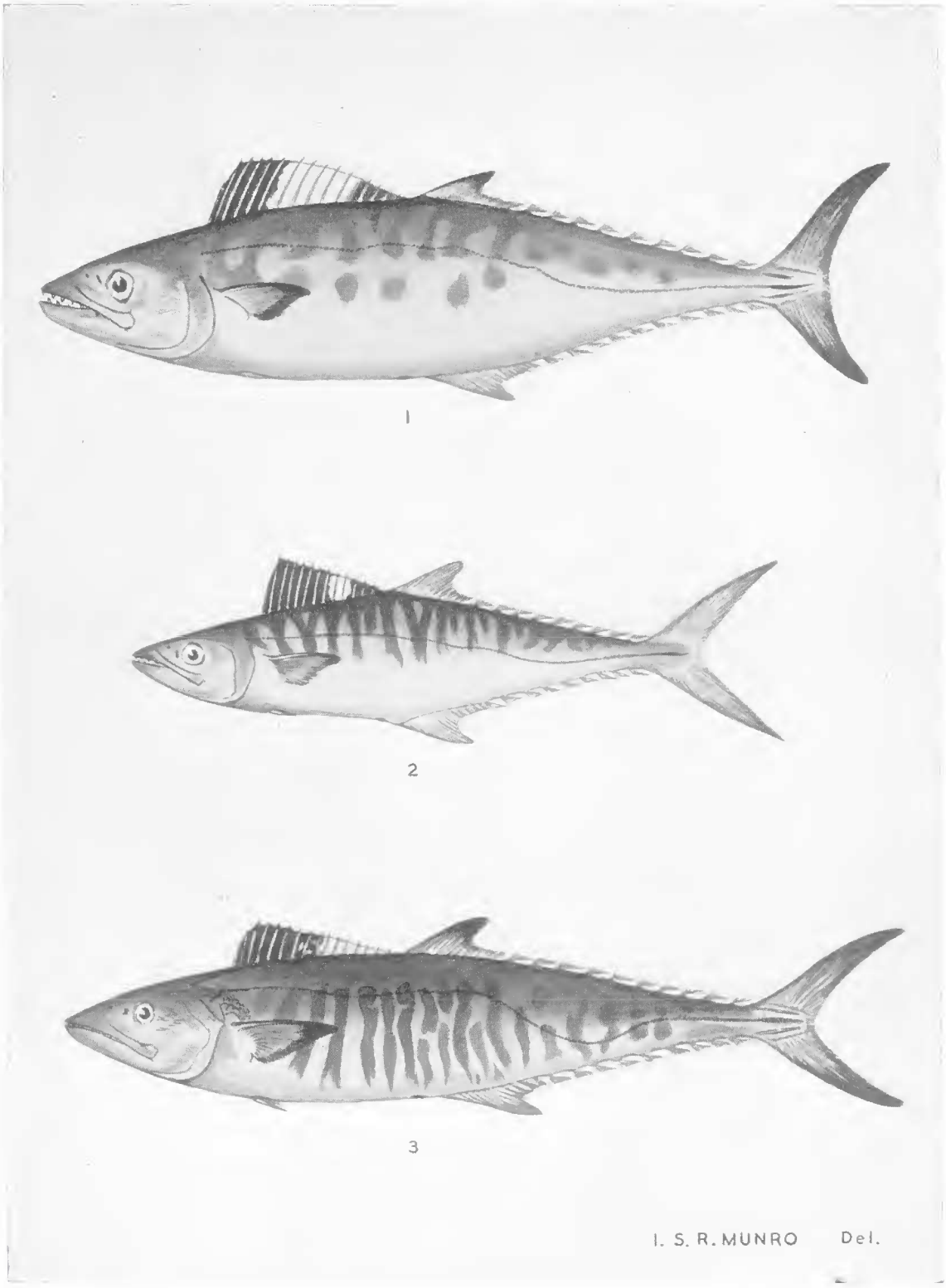
TABLE XI.—FIN COUNTS OF *S. semifasciatus.* SERIES FROM THE QUEENSLAND COAST.

No. of spines and rays.	8	9	10	13	14	15	17	18	19	20	21	22	23	Total No. of Individuals.
1st Dorsal ..				2	7	7								16
2nd Dorsal ..							1	2	13	2				18
Dorsal Finlets	2	11	3											16
Anal ..										3	13	2		18
Anal Finlets	3	10	3											16
Pectoral ..												2	10	12

The range of variation in fin counts are thus—
D, 13-15 ; 17-20 ; 8-10. A. 20-22 ; 8-10 ; P, 22-23.

The average (*i.e* modal) fin formula can be taken as—
D, 14 + 19 + 9. A, 21 + 9. P, 23.

This formula is identical with the fin count in De Vis' holotype of *Cybium tigris* as recounted by Whitley (1936).



Australian Spanish Mackerel.

Fig. 1.—*Scomberomorus* (*Cybium*) *queenslandicus* sp. nov. Immature specimen from Brisbane River, Queensland. Queensland Museum Collection Registered No. I. 7073. Length to caudal fork = 193 mm.

Fig. 2.—*Scomberomorus* (*Indocybium*) *semifasciatus* (Macleay). Juvenile specimen from Townsville district, North Queensland. Length to caudal fork = 140 mm.

Fig. 3.—*Scomberomorus* (*Cybium*) *commerson* (Lacépède), "School Mackerel." Immature specimen from Mackay district, North Queensland, 4th September, 1941. Length to caudal fork = 368 mm.

The shape of the pectoral fin calls for special comment. Unlike most other Scomberomoridae the pectoral fin is not falcate. At least in older fish the margins of the pectoral fin are rounded. The anterior or upper margin is distinctly convex and the lower or posterior margin is slightly concave or even sigmoid in outline. The shape is quite characteristic and is often useful in identifying the species.

(*d*) *Body proportions.*

TABLE XII.—BODY PROPORTIONS OF *Scomberomorus semifasciatus*. SERIES FROM QUEENSLAND COAST—TOWNSVILLE TO MORETON BAY. SIZE RANGE (L.C.F.) 168mm. TO 595mm.

Ratio.	Number of Specimens.	Observed Range.		Mean.	σ	Coefficient of Variation.
		Minimum.	Maximum.			
Head length/snout length	9	2·43	2·75	2·55	0·083	3·2%
Head length/eye diameter	9	5·72	8·18	6·98	0·530	7·7%
Head length/inter-orbital	8	2·83	3·24	2·98	0·122	4·1%
Head length/maxilla length	8	1·25	1·67	1·42	0·150	10·5%
Head length/pectoral fin length	9	1·67	1·96	1·81	0·086	4·8%
Body length/head length	9	4·43	5·09	4·95	0·220	4·5%
Body length/snout to origin of 1st dorsal fin	9	3·92	4·31	4·12	0·120	2·9%
Body length/snout to origin of 2nd dorsal fin	9	2·06	2·16	2·12	0·031	14·6%
Body length/snout to origin of ventral fins	8	3·82	4·31	4·07	0·165	4·0%
Body length/snout to vent	9	2·07	2·18	2·13	0·045	2·1%
Body height/interaxillary width	4	1·87	2·06	1·95	0·071	3·7%
Body length/body height at level of vent + height of 2nd dorsal fin + height of anal fin	6	1·90	2·03	1·95	0·045	2·3%
Body length/length of upper + length of lower caudal lobes	7	2·04	2·76	2·27	0·219	9·6%

In table XII is set out the variation in the principal body proportion ratios along with their mean value and standard deviation. It can be seen at a glance that this species is readily distinguishable from both *S. commerson* and *S. queenslandicus* by reference to body proportions only. The significant differences are :—

(1) Eye diameter relatively larger than in *S. commerson* and *S. queenslandicus*.

(2) Height of body at level of vent + height of 2nd dorsal fin + height of anal fin is relatively greater than in subgenus *Cybium*, *i.e. S. semifasciatus* has a mean value of 1·95 for this ratio as compared with 2·6 for *S. commerson* and *S. queenslandicus*. This feature is very striking and gives the body outline of *S. semifasciatus* a characteristic diamond shape.

(3) The caudal fin is wider (*i.e.* the tail is larger) in *S. semifasciatus* than in other Australian species. This ratio of body length/length of upper + length of lower caudal lobes has a mean value of 2·27 as compared with 3·09 and 3·37 in *Cybium* subgenus. The difference in size of the tail is very noticeable, so much so, that it is possible to detect examples of *S. semifasciatus* in a market consignment of *S. commerson* by reference to the tails only.

Casual observation would suggest that the ratio of body length/head length is relatively large, or in other words the head is small compared with the body length. It will be seen from reference to tables IV, VI and XII that this ratio is no greater in *S. semifasciatus* than in *S. commerson* or *S. queenslandicus*. The effect is apparently the result of an optical illusion caused by the disproportionately small body length/body height ratio.

In the field it is always possible to identify *S. semifasciatus* by—

(*a*) Its large tail ;

(*b*) Its great body depth in region of soft dorsal and anal fins, producing a diamond shaped outline ;

(*c*) What appears to be a relatively small head ;

(*d*) Possession of extraordinarily broad fleshy lateral keels on either side of the tail. Comparatively speaking these lateral keels are larger than those of any other Australian species of *Scomberomorus*.

(*e*) *Internal Anatomy.*—The arrangement and proportions of the visceral organs are as illustrated in Text-figure 2, No. 3. The liver is small, distinctly tri-lobed and of a uniform brown colour as in other species. The pyloric tubules are small and very numerous as in subgenus *Cybium* (*cf.* Nos. 4 and 5). The spleen is relatively smaller than in *Cybium* and *Sawara*. The lower intestine has two loops only (*cf.* four loops in *Cybium*). There does not appear to be an air-bladder present.

(*f*) *Gill-rakers.*—The number of gill-rakers in this species has never been stated by other authors. They were not given in the brief descriptions of the holotypes of *C. semifasciatum* Macleay or of *C. tigris* De Vis. The range of variation in this character has been found to be—Upper limb of first arch = 2 or 3, lower limb of first arch = 7 to 9 short smooth rakers. A typical gill-arch is illustrated in Text-figure 3. The most usual gill-raker count is probably = 2 + 8.

(*g*) *Lateral-line.*—The lateral-line is almost straight or at most only slightly sigmoid. It descends gently in the region below the spinous dorsal fin and then more steeply under the soft dorsal fin and first few dorsal finlets. It then follows a horizontal course to the caudal keels. There are about 175 to 190 scales along the course of the lateral-line. It is not branched.

(*h*) *Vertebrae.*—The vertebrae have been counted in only four specimens, all of which come from the eastern coast of Australia. Three of these have 19 precaudal vertebrae and 26 caudal (excluding hypural) vertebrae, with a total count of 45. One specimen, however, shows a slight variation in that there is one less caudal vertebra, *i.e.* with a count as follows :—19 + 25 = 44. The average vertebral count can be considered as being 19 + 26 = 45.

3. Synonymy.

Cybium semifasciatum Macleay, Proc. Linn. Soc. N.S.W., viii 1883, pp. 205-206 (Lower Burdekin River, Qld.) ; Macleay, Proc. Linn. Soc. N.S.W. ix, 1, 1884, p. 28 ; Whitley Mem. Qld., Mus., xi, 1, 1936 pp. 40-42 figs. 3-4 (in part).

Cybium tigris De Vis Proc. Linn. Soc. N.S.W. ix 3, 1884 p. 545 (Cape York).

Scomberomorus semifasciatus McCulloch & Whitley, Mem. Qld. Mus., viii, 2, 1925, p. 142 ; McCulloch, Aust. Mus. Mem., V, 1929, p. 264.

Scomberomorus tigris McCulloch & Whitley Mem. Qld. Mus. viii 2, 1925, p. 142 ; McCulloch Aust. Mus. Mem. v, 1929, p. 264.

Cybium commersonii Saville-Kent, Great Barrier Reef of Aust., 1893, p. 291, p. 311 (in part) and his Pl. XLVI, fig. 1.

Scomberomorus commersonii Stead, Edible Fishes N.S.W., 1908, p. 98 (in part) and his Pl. LXVI.

Cybium guttatum Rendahl, Klungl. Svenska, Akad. Handl., lxi, 9, 1921, p. 16 ; Whitley, Mem. Qld. Mus., xi, 1, 1936, pp. 39-40 (in part).

4. General Discussion on Diagnosis.—Having likewise examined and compared both Macleay's shrunken holotype of *C. semifasciatum* from Burdekin River (Aust. Mus. Regd. No. A.18288) and De Vis' holotype of *C. tigris* (Qld. Mus. Regd. No. I.119) from Cape York, I concur with Whitley (1936) in that these two are conspecific. Further they belong to the same species as here described. Although there can be no grounds for the idea that De Vis' fish is the young of *S. commerson* there is abundant evidence to indicate that *S. semifasciatus* has in the past been confused with both the commoner *S. commerson* and even *S. queenslandicus*. The illustrations of Saville-Kent (1893) and Stead (1908) represent typical examples of *S. semifasciatus* wrongly named. It might also be stated here that a number of specimens in the Australian Museum collection (I.5296, I.5297, I.5298, I.5299, I.15275, IA.7669, IA.7670) are also wrongly labelled as *S. commerson*. Their correct identity is *S. semifasciatus*. In this connection also it is apparent from examination of specimens that the examples of "*C. semifasciatum*" in the Australian Museum collection (IA.1598, IA.6573) as described by Whitley (1936) are typical examples of *S. queenslandicus*. Rendahl's example from Broome (N.W. Australia) described as "*C. guttatum*" would appear also to belong to this *S. semifasciatus*.

ACKNOWLEDGMENTS.

The greater part of the research involved in the above study was carried out in the capacity of Walter and Eliza Hall Research Fellow in Economic Biology at the University of Queensland, to the Trustees of which the author expresses appreciation. Grateful acknowledgment is extended to all who have in any way assisted in making this contribution possible. The Chief of the C.S.I.R. Division of Fisheries, Dr. H. Thompson and his staff, particularly Mr. G. L. Kesteven and Dr. D. L. Serventy have given guidance throughout this study and made available both collecting and laboratory facilities. The Directors of the Queensland Museum (Mr. H. Longman) and the Australian Museum have made available specimens for examination and given access to the valuable reference libraries of those institutions.

For assistance given and facilities afforded in the gathering of data in the field, appreciation is extended to Mr. J. W. D. Dick and Inspectors R. Blackburn and W. Hiddins of the Department of Harbours and Marine, Queensland; to the Queensland Fish Board; to Mr. J. Lihou and Inspectors R. Govan and P. Ludwig of Brisbane; to innumerable fishermen particularly J. Riley (Brisbane), A. Smith (Bundaberg) and P. Krohn (Townsville); and especially to Mr. G. Coates of Townsville who has made available much helpful material and information. Lastly, I wish to extend thanks to Mr. T. C. Marshall, Assistant Chief Inspector of Fisheries, who has done much to encourage this particular study.